NAVAL RESEARCH LABORATORY'S

VXS-1, Patuxent River, MD

NRL-DC, Washington, DC

NRL-SSC, Mississippi

Ex-USS Shadwell, Mobile, AL

NRL-MRY, Monterey, CA

CBD, Chesapeake Beach, MD

2005

MAJOR FACILITIES

CONTENTS

2005 NRL MAJOR FACILITIES

- Fiber Fabrication Facility for Nonoxide and Specialty Glasses
- Nanochannel Glass Technology Facility
- Organic Opto-Electronics Fabrication and Characterization Facility
- Fiber-Optic Optical-Microwave Laboratory
- IRCM Techniques Laboratory
- Missile Warning System Facility
- Infrared Range Facility
- Fiber-Optic Sensor Facility
- Oxide Optical Fiber Fabrication Facility

Code 5700 – Tactical Electronic Warfare Division

- Visualization Laboratory
- Transportable Step Frequency Radar
- Vehicle Development Laboratory
- Offboard Test Platform
- Compact Antenna Range Facility
- Isolation Measurement Chamber Facility
- RFCM Techniques Chamber Facility
- Search Radar ECM/EA Simulator
- Low-Power Anechoic Chamber
- High Power Microwave Research Facility
- Electro-Optics Mobile Laboratory
- Infrared/Electro-Optical Calibration and Characterization Laboratory
- Infrared Missile Simulator and Development Laboratory
- Secure Supercomputing Facility
- CBD/Tilghman Island IR Field Evaluation Facility
- Ultra-Short Pulse Laser Effects Research and Analysis Laboratory
- Central Target Simulator Facility
- Flying Electronic Warfare Laboratory

MATERIALS SCIENCE AND COMPONENT TECHNOLOGY DIRECTORATE

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- Automatic X-ray Diffractometers
- Atomic Force Microscope

Code 6100 – Chemistry Division

- Chemical Analysis Facility
- Magnetic Resonance Facility
- Corrosion Engineering and Coatings Characterization Facilities
- Marine Corrosion Facility
- Chemical Vapor and Plasma Deposition Facility

- Nanometer Characterization/Fabrication Facility
- Synchrotron Radiation Facility
- Ex-USS *Shadwell* Advanced Fire Research Ship
- Fire Research Enclosure
- Large-Scale Damage Control Facility

Code 6300 – Materials Science and Technology Division

- Materials Processing Facility
- 3-MV Tandem Pelltron Accelerator
- Micro-Nano Structure Characterization Facility
- Mechanical Characterization Facility
- Electrical, Magnetic, and Optical Measurement Facility
- Thin Film Materials Synthesis and Processing Facility
- Magnetoelectronics Fabrication Facility

Code 6400 – Laboratory for Computational Physics and Fluid Dynamics

- Parallel High-Performance Computer Graphics Facility

Code 6700 – Plasma Physics Division

- Nike KrF Laser Facility
- Electra Laser Facility
- Pharos Laser System
- Large Area Plasma Processing Systems
- Space Physics Simulation Chamber
- Gamble II
- Hawk
- Mercury
- High-Frequency Microwave Processing of Materials Laboratory
- T-Cubed Laser System
- TFL Laser System

Code 6800 – Electronics Science and Technology Division

- Ultrafast Laser Facility
- Space Solar Cell Characterization Laboratory
- Vacuum Electronics Fabrication Facility
- Compound Semiconductor Processing Facility
- The MOCVD Laboratory
- Epicenter for Advanced Materials Growth and Characterization

Code 6900 – Center for Biomolecular Science and Engineering

- Micro Fabrication Facility for Microfluidics

- Quadrupole Time-of-Flight Mass Spectrometer
- Advanced Microscopy Facility

OCEAN AND ATMOSPHERIC SCIENCE AND TECHNOLOGY DIRECTORATE

Code 7100 – Acoustics Division

- Acoustic Communications Measurement System
- High-Frequency Acoustic Flow Visualization Systems
- Instrumentation Suite for Acoustic Propagation Measurements in Complex Shallow Water Environments
- Rail-based Broadband Synthetic aperture Ocean Measurement System
- Structural Acoustics In-Air Facility
- Laboratory for Structural Acoustics
- Shallow Water Acoustic Laboratory
- Autonomous Acoustic Receiver System
- Salt Water Tank Facility
- Underwater Acoustic Time-Reversal Mirror
- Shallow-Water High-Frequency Measurement Systems

Code 7200 – Remote Sensing Division

- Naval Prototype Optical Interferometer (NPOI)
- Optical Spectral Measurements Facility
- Free Surface Hydrodynamics Laboratory

Code 7300 – Oceanography Division

- Ocean Sciences and Remote Sensing Research Facility
- Environmental Microscopy Facility
- Ocean Dynamics and Prediction Network
- Ocean Color Facility
- Littoral Current Measurement Facility
- Scanning Slope Sensing and Wave Gauge Array Buoy
- Salinity Temperature and Roughness Remote Scanner
- Field Staging Facility
- Ocean Optics Instrumentation Systems

Code 7400 – Marine Geosciences Division

- Electron Microscopy Facility
- Sediment Physical and Geoacoustic Properties Laboratory
- Marine Biochemistry Laboratory
- Computed-Tomography Scanning Facility
- Moving-Map Composer Facility
- AUV Prototype Development Facility

Code 7500 – Marine Meteorology Division

- METOC Research Laboratory
- Meteorological Computing and Archival Facility
- Atmospheric Prediction System Development Laboratory
- Mobile Atmospheric Aerosol and Radiation Characterization Observatory
- Satellite Data Ingest and Processing System

Code 7600 – Space Science Division

- Vacuum Ultraviolet Calibration/Testing Facility
- Gamma-Ray Imaging Laboratory
- Cryogenic Sensor Test Facility
- Large Angle and Spectrometric Coronagraph
- Rocket Assembly and Checkout Facility
- Solar Coronagraph Optical Test Chamber
- Space Instrument Test Facility
- EUV/X-Ray Calibration Facility

NAVAL CENTER FOR SPACE TECHNOLOGY

Code 8100 – Space Systems Development Department

- Precision Radio Frequency Anechoic Chamber Facility
- Satellite Mission Analysis Facility
- Blossom Point Satellite Tracking and Command Station
- Midway Research Center Precision Spacecraft Calibration Facility
- Precision Clock Evaluation Facility

Code 8200 – Spacecraft Engineering Department

- Modal Survey Test Facility
- Static Loads Test Facility
- Payload Processing Facility
- Thermal Vacuum Test Facility
- Spacecraft Acoustic Reverberation Chamber Test Facility
- Spacecraft Spin Test Facility
- Spacecraft Vibration Test Facility
- Spacecraft Thermal Analysis, Fabrication, and Test Facility
- Spacecraft Robotics Engineering and Controls Laboratory
- Class 100 Clean Room Facility
- Radio Frequency Anechoic Chamber Facility
- EMI Test Facility

GENERAL INFORMATION

- Maps

EXECUTIVE DIRECTORATE

Code 1100 – Nanoscience Research Laboratory

Code 1600 – Scientific Development Squadron One (VXS-1)

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Institute for Nanoscience

Nanoscience Research Laboratory

Nanoscience Research Laboratory

Nanoscience Research Laboratory

FUNCTION: The U.S. Navy, known for its enormous aircraft carriers and nuclear submarines, now has the opportunity to exploit the world of the very small for its next generation of technology. Future technology will be increasingly based upon materials and devices fabricated at the atomic scale (measured in nanometers – billionths of a meter). And because it understands both nanoscience and the needs of the Navy, NRL is uniquely positioned to bring that knowledge to bear to benefit our warfighters and our nation.

Toward increasing that understanding, NRL has established an Institute for Nanoscience to conduct multidisciplinary research at the intersection of the fields of materials, electronics, and biology at the nanometer-length scale. The Institute serves as NRL's nucleus of collaborative activity in this rapidly evolving research area.

DESCRIPTION: In support of this new initiative, NRL has constructed a major new facility at its Washington, DC, location. The new facility, opened in October 2003, is administered by the Institute Director. It houses approximately 5,000 square feet of Class 100 fabrication clean rooms and an equal area of specialized, acoustically quiet and ultraquiet laboratory space to carry out research in this demanding regime, under very carefully controlled conditions. Here, postdoctoral students, scientists, and developers can learn firsthand from the scientists who developed the material, equipment, or technique.

CONTACT:
Code 1100 • (202) 767-1803
LOCATION:
NRL, Washington, DC

Scientific Development Squadron One (VXS-1)

- Scientific Development Squadron One (VXS-1)

Scientific Development Squadron One (VXS-1)

NP-3D Orion aircraft

RC-12 King Air aircraft

FUNCTION: Operates and maintains a fleet of three uniquely configured, research modified NP-3D Orion aircraft and one uniquely configured, research configured RC-12 King Air aircraft to support a wide spectrum of projects and experiments. The Commanding Officer of Scientific Development Squadron One (VXS-1) is responsible for setting policy, scheduling aircraft assets, and managing the daily activities of the Squadron.

DESCRIPTION: Located on the western shore of the Chesapeake Bay at Naval Station Paxtuxent River, Maryland, VXS-1 encompasses a 15,900-ft^2 aircraft hangar, a 5,600-ft^2 Executive and Operations Headquarters building, three research projects facilities buildings, three storage buildings, and one aircraft movement support facility. The Naval Air Station provides two runways and a large number of aircraft support services.

Research assets include three NP-3D Orion aircraft and one RC-12 King Air aircraft configured to perform numerous airborne research projects, including bathymetry, electronic countermeasures, gravity mapping, and radar development research. Included in the inventory is the Navy's only Rotodome P-3 aircraft. The RC-12 is the squadron's newest asset and was acquired in October 2005.

CONTACT:
Code 1600 • (301) 342-3751
LOCATION:
Naval Air Station, Patuxent River, MD

BUSINESS OPERATIONS DIRECTORATE

Code 3400 – Supply & Information Services Division

Code 3500 – Research and Development Services Division

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Supply & Information Services Division

- DocuColor 2045 - Print on Demand System
- Video Editing
- Photographic Services

DocuColor 2045 – Print-on-Demand System

DocuColor 2045 print-on-demand system

FUNCTION: Produces color output from digital files or hard-copy originals. The DocuColor 2045 is a print-on-demand system, which is most economical for short-run (500 copies or less), fast turn-around color printing.

INSTRUMENTATION: The DocuColor 2045 uses a four-color process, toner-based print engine and traditional cyan, magenta, yellow, and black colors found on offset color printing presses. It has a Fiery front end for high-resolution raster image processing.

DESCRIPTION: The DocuColor 2045 system is both a copier (for printing from the glass) and a printer (for printing from digital files). It prints consistent, high-quality color at 600 × 600 dpi. Every page is an original. It features a wide range of color, image, and output controls, whether printed from the glass or from the Fiery digital front end. In its normal mode, the DocuColor 2045 prints at 45 pages per minute. Short jobs can literally be done while you wait. Two-sided printing is also available. The DocuColor 2045 prints on a variety of paper stock. Standard paper is a premium 24-lb stock that produces excellent output. We also have heavier paper, either coated or uncoated, to meet your specific requirements. The largest paper size is 12 × 18 in. The DocuColor 2045 also has the capability to make full-color transparencies from your artwork or photographs.

CONTACT:
TIS Service Desk • Code 3430 • (202) 767-3500
LOCATION:
NRL, Washington, DC

Video Editing

AVID Symphony digital editing system

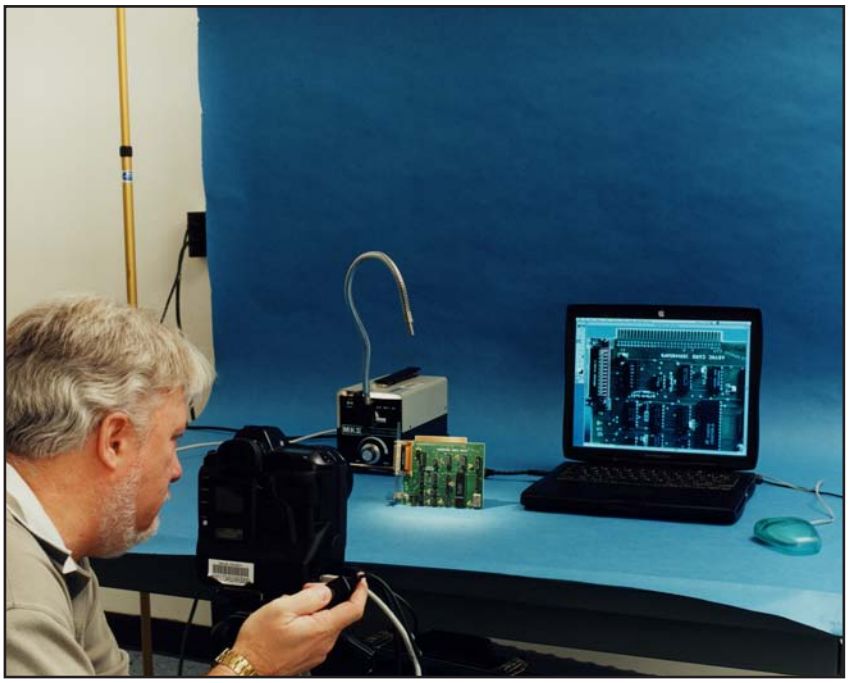
FUNCTION: Provides the capability to author/produce/edit classified and unclassified multimedia programs for the Laboratory community.

INSTRUMENTATION: Three Power Mac G4s running Avid's Symphony and Xpress-Pro DV system; Boris Red for broadcast quality titling, compositing, and 3D animation; and DVD Studio Pro 3 for DVD authoring.

DESCRIPTION: This facility features three multimedia systems running on software designed to provide the highest quality level video postproduction work appropriate for your project needs. Our facility is broadly based. Our major services include tape dubbing from multiple source to multiple formats, sound and narration overdubbing, voice enhancement, script reading, and video nonlinear editing to produce concise informative professional quality movies in most every major CD, DVD, and internet playable format. We offer the option of shooting the footage for you or using footage you have created from in-house cameras.

CONTACT:
Code 3432 • (202) 767-3536
LOCATION:
NRL, Washington, DC

Photographic Services



NRL photographer using one of several digital cameras.

FUNCTION: Provides the capability to photographically capture a wide variety of scientific and technical experiments, tests, exhibits, portraits, and newsworthy items, and to produce high-quality color and black and white prints and transparencies from digital image files.

EQUIPMENT: A Kodak DCS Pro14N digital camera with full-color resolution of 3000 × 4500 pixels is used for image capture. Workstations include several Macintosh G5 systems. Images are output to a Fuji Pictrography 4000 thermal dye transfer printer, an Encad Novajet Pro 600E large format inkjet printer, an HP 5500 large format printer, and a Noritsu dDP-411 digital minilab.

DESCRIPTION: This facility maintains a staff of highly skilled scientific and technical photographers experienced in providing high-quality photographic documentation in high-resolution digital format. High-quality images in both color and black and white are provided by a staff of skilled computer specialists, photographers, and visual information specialists. These images are produced from digital files that are received from image capture, film negative and hard-copy scans, graphic creation, or the computer network, and are output to various high-resolution printers. Image files can also be written to CD-ROM.

CONTACT:
Code 3432 • (202) 767-1978
LOCATION:
NRL, Washington, DC

Research and Development Services Division

- Chesapeake Bay Detachment

Chesapeake Bay Detachment (CBD)

Chesapeake Bay Detachment field site

FUNCTION: Operates and maintains a unique land, sea, and air facility for NRL research. It has a variety of plant facilities and specialized equipment to support NRL and tenant research and development projects.

INSTRUMENTATION: The principal investigator is responsible for all instrumentation and test equipment.

DESCRIPTION: The main site at Randle Cliff (Chesapeake Beach), Maryland, covers 157.6 acres contiguous to the Chesapeake Bay with a 0.75-mile waterfront. It is located in a relatively clear area away from congestion and industrial interference. The facility maintains towers for antenna support and a ship motion simulator. Off-site facilities include a 2.6-acre site with a 75-ft tower located 10 nmi east at Tilghman Island, Maryland, and small-craft berthing located in the town of Chesapeake Beach, 2 nmi north of the main site. A test control center for air and sea operations is available to researchers who use the NRL/CBD test range. The test range is a restricted zone directly east of the main site and extends across the bay.

Research watercraft include a 74-ft LCM-8 and a 22-ft Boston Whaler. These are used primarily in support of research projects and secondarily as transport to Tilghman Island.

CONTACT:
Code 3522 • (410) 257-4002
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

SYSTEMS DIRECTORATE

Code 5300 – Radar Division

Code 5500 – Information Technology Division

Code 5600 – Optical Sciences Division

Code 5700 – Tactical Electronic Warfare Division

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Radar Division

- Advanced Multifunction Radio Frequency Concept Test Bed
- Radar Imaging Facility
- Airborne Early Warning Radar Facility
- Radar Signature Calculation Facility
- Compact Range Facility
- Airborne Surveillance Command and Control Research Platform
- Millimeter Wave Radar Facility
- Radar Test Facility
- Microwave Microscope

Advanced Multifunction RF Concept (AMRFC) Test Bed

Advanced Multifunction RF Concept (AMRFC) Test Bed

FUNCTION: The AMRFC test bed was developed as a proof of principle demonstration system that is capable of simultaneously transmitting and receiving multiple beams from common transmit and receive array antennas for radar, electronic warfare, and communications. These RF functions are controlled by common resource allocation manager (RAM) software over a real-time control network. New RF functionality may be readily added to the test-bed as required for further demonstrations.

INSTRUMENTATION: The test bed consists of separate active transmit and receive arrays that operate over the 6- to18-GHz band (nominally). Current functionality includes a multimode navigation/surface surveillance Doppler radar, multiple communication links (line of sight and satellite), and passive and active electronic warfare capabilities. Additionally, several fixed dish antennas are located at the site for testing with equipment located at Tilghman Island. An over-the-air Ethernet link was also developed for remote control of Tilghman Island equipment.

DESCRIPTION: Test-bed electronics are housed in seven converted 20-ft shipping containers, or trailers. The arrays are mounted on a 15-degree slope in the ends of two of the trailers overlooking the Chesapeake Bay, emulating a possible shipboard installation. Packaging of the test-bed electronics into trailers provides the ability to support laboratory equipment in a protected environment, as well as provides options to transport test-bed assets to other test locations, such as aboard ship. One set of stacked trailers is allocated to the transmit array and associated signal generation electronics. A second stacked trailer pair is allocated to the receive array and associated digital receiver, digital beamforming, and electronic surveillance receive electronics. A fifth trailer houses the test-bed communication electronics, and the remaining two trailers provide the central processing, displays, and operations electronics. Additionally, a portable power plant, dry air supply and chiller unit provide the test-bed power and array cooling.

CONTACT:
Code 5303 • (202) 404-1945
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Radar Imaging Facility

Radar Imaging Facility Raid Storage System, real-time processor, and VLDS recorder units

FUNCTION: Provides the capability to produce real-time and nonreal-time synthetic aperture radar and inverse synthetic aperture radar (SAR and ISAR) imagery. This facility contains the processing, data storage, and the image display and recording resources to handle data from a number of platforms and also serves as an environment for the development of advanced imaging algorithms.

EQUIPMENT: The facility provides very large data store (VLDS) data recorders for playback of data tapes and standard video generation and recording capability for the production of live video recordings. Two VME-based systems are available for interfacing other data recorders, custom interfaces, or other VME-based instrumentation.

DESCRIPTION: The general computing resources that are available include three Sun workstations, three SGI workstations, and two PC-based workstations (running Linux). In addition, there are two VME-based multiprocessor systems: one system with four I-860 processors and one system with 12 Power-PC processors, which provide real-time processing capability. Data storage is provided by two Raid systems, with a combined storage capacity of 650 GB. All systems are connected by a 100-Mbs network, which also provides connectivity to the other branch facilities. Video scan converters provide the capability to record the video from any of the workstations and real-time processors, and a separate video facility provides video editing capabilities.

CONTACT:
Code 5313 • (202) 404-1979
LOCATION:
NRL, Washington, DC

Airborne Early Warning Radar Facility

Ten-element AAFTE airborne radar array antenna

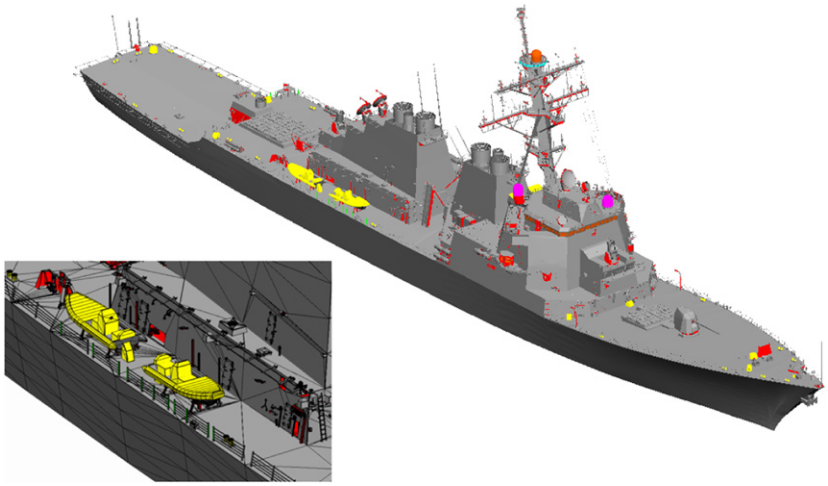
FUNCTION: Collects, reduces, and analyzes airborne radar data and identifies, develops, and evaluates new techniques for improving the performance of airborne radars. Nearly all new techniques require radars employing multi-element, multichannel antenna arrays. Of particular interest is Space Time Adaptive Processing (STAP), a technique for optimizing radar detection performance in the presence of jamming and clutter.

INSTRUMENTATION: Includes an extensively modified APS-125 radar receiver system; a 10-element Adaptive Array Flight Test Equipment (AAFTE) antenna for collecting multichannel airborne array radar data; a rack-mounted STAP pre- and post-processor; a simulation and evaluation suite; and three UNIX computer workstations.

DESCRIPTION: The facility includes a data and signal processing laboratory, and the l0-element AAFTE airborne radar array antenna and STAP laboratory, which are both located in Bldg. 42. Data collected using the AAFTE antenna were used in the first successful demonstration of STAP processing.

CONTACT:
Code 5313 • (202) 404-1993
LOCATION:
NRL, Washington, DC

Radar Signature Calculation Facility



CAD model of USS *The Sullivans* (DDG-68)

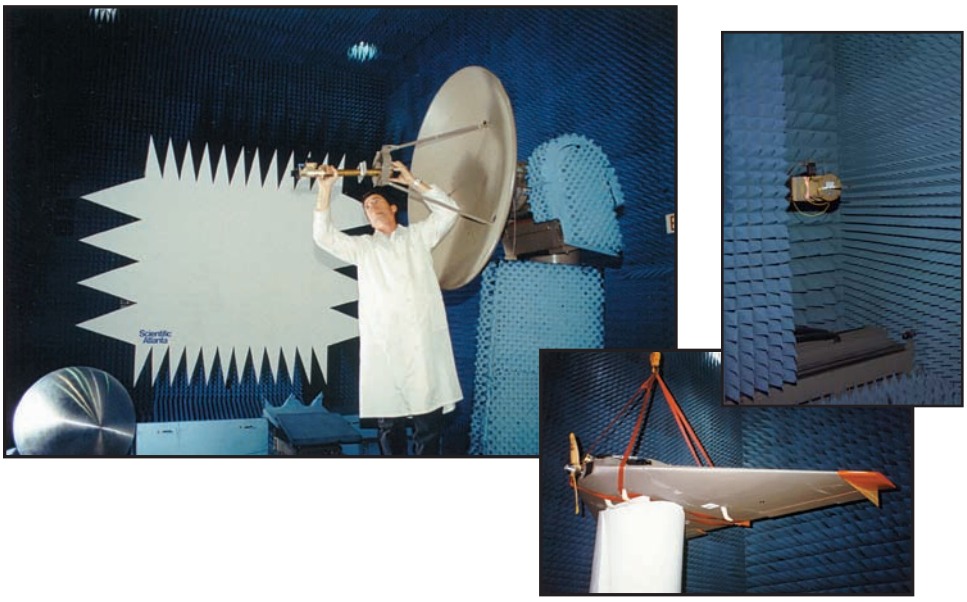
FUNCTION: The calculation, analysis, and visualization of the spatially extended radar signatures of complex objects such as ships in a sea multipath environment and phased-array antennas. Radar signatures that are typically calculated include total radar cross section (RCS), high range resolution (HRR) profiles, and inverse synthetic aperture radar (ISAR) images. The facility has been used on numerous Navy programs including the design and live fire test and evaluation of the DDG-51 and LPD-71class ships.

INSTRUMENTATION: The facility currently consists of an SGI Origin 2400 parallel computer with 32 processors and 32 GB of physical memory, an SGI Fuel and dual-processor Octane graphics workstations with 2 GB of physical memory each, several smaller UNIX workstations and INTEL x86 computers, and a General Dynamics TACLANE KG-175 for secure communications with a shared facility containing two SGI Origin 3800 parallel computers (128 processors and 128 GB of physical memory and 48 processors and 48 GB of physical memory, respectively).

DESCRIPTION: The facility consists of several high-performance computers for calculating the radar signatures of complex objects such as ships and phased-array antennas. The radar signatures are calculated from computer-aided design (CAD) models that describe the geometry and material properties of objects. The facility currently includes models of the FFG-7, DD-963, DDG-51, CG-47, PC-9, LPD-17, and CVN-68 class ships. A large collection of CAD models of individual ship components such as antennas, weapons systems, and deck equipment is also available. The radar signatures of large objects are calculated using the Radar Target Signature (RTS) model. The RTS model is based on high-frequency scattering techniques and was developed by the Radar Division specifically for calculating the radar signature of ships in a sea multipath environment. The radar signature of smaller objects such as phased-array antennas can be accurately calculated using any of several low-frequency computational electromagnetic software packages available within the facility.

CONTACT:
Code 5314 • (202) 404-8602
LOCATION:
NRL, Washington, DC

Compact Range Facility



Compact Range Facility

FUNCTION: Measures electrical properties and characteristics of antenna systems and performs radar cross section (RCS) measurements of objects. These data are used to verify and optimize the designs of new or existing platforms.

INSTRUMENTATION: The facility contains an Agilient E8362A microwave receiver (with external mixers) that is capable of operating from 1 to 110 GHz, a five-axis positioner controller, a pulsed continuous wave (CW) system used for RCS measurements and a 2-axis near-field scanner positioner unit. The data collection system is controlled by the FR 959 antenna/RCS software package and uses several computer systems for data analysis and acquisition. The software also includes inverse synthetic aperture radar imaging capabilities.

DESCRIPTION: The facility is operated by the Radar Division and is located in Building A-59 room 11A1 (Door B). It contains a Scientific Atlanta Model 5706M compact range reflector that produces simulated far-field conditions from 1 to 110 GHz with a quiet zone (maximum usable size) of approximately 7 ft in diameter and 8 ft in length. The compact range reflector is housed in an environmentally and mechanically stable room that measures 20 ft x 20 ft x 40 ft. The chamber also includes a near-field scanner that is capable of scanning a 12 x 18-ft region and can be configured for planar, cylindrical, or spherical near-field testing. The system also incorporates a FARO Laser Tracker unit that is able to optically track the test probe to within an angular resolution of 0.02 arcseconds. This enables the scanner to be operated at millimeter wavelengths without any performance degradation.

CONTACT:
Code 5317 • (202) 767-6277
LOCATION:
NRL, Washington, DC

Airborne Surveillance Command and Control (ASC^2) Research Platform

Airborne Surveillance Command and Control (ASC^2) research aircraft

FUNCTION: Acts as a surrogate for carrier-based surveillance, engagement, communication relay, combat identification, and command-and-control capable assets of the evolving family of systems warfare architecture. In addition to the integrated AN/APS-145-based airborne early warning/cooperative engagement capability (AEW/CEC) suites, the aircraft is designed to accommodate command and control (C^2), electronic warfare (EW), radar, and electro-optics (EO) research and development (R&D) programs well into the next century.

DESCRIPTION: The NRL Airborne Surveillance Command and Control (ASC^2) research aircraft is an NP-3D aircraft integrated with a full E-2C AEW Hawkeye 2000 suite, which includes the full CEC. This heavyweight P-3B is configured with a Hawkeye 2000 AEW system and an Airborne CEC suite to support the Navy's future AEW/CEC network centric warfare programs. In addition to the AEW/CEC installation, there are floor and ceiling rails to accommodate six additional operator/equipment consoles in the aft crew compartment, a free-fall sonobuoy chute, space for mounting up to 700 lb of equipment in the forward equipment area, and cross-decked Joint Tactical Information Distribution System (JTIDS) Class II equipment. External wing wiring is installed, including fiber optics to support six external electronic pods. The nose radome area has been fitted for a modified Infrared Radiation Detection System (IRDS) turret that can be lowered and raised to support electro-optical projects. Additional structure mountings are in the nose and tail to accommodate the installation of project antennas. The aircraft can accommodate an additional internal payload of up to 2,800 lb, external payloads of up to 10,000 lb, and a crew of up to 16 people, including military flight crew and project scientists. The avionics suite includes a state-of-the-art, digitally controlled analog ICS system; dual INS; SATCOM; GPS; seven ultrahigh-frequency (UHF), four very-high-frequency (VHF), and two high-power high-frequency (HF) communications systems, all of which are secure communications capable and available for project use. Additionally, it is outfitted with four 90-kVA generators, wired to accommodate future growth of two 120-kVA generators.

CONTACT:
Code 5318 • (202) 767-3475
LOCATION:
NRL, Washington, DC

Millimeter Wave Radar Facility

Shelters housing the high-power 94-GHz radar

FUNCTION: Experimental high-power 94-GHz tracking radar system (WARLOC) for use in research involving target cross-section measurement, propagation effects, radar imaging, cloud research, and other research that requires very-high-range and angular resolution.

INSTRUMENTATION: Real-time radar control, signal processing, and image formation are accomplished with a VME-based system. An optical tracking system is mounted on the antenna to help in target acquisition at short range.

DESCRIPTION: The WARLOC radar is housed in a relocatable radar facility that consists of two equipment shelters, a chiller for cooling the transmitter, and a 175-kVA diesel generator for use at remote sites. A 40-ft long shelter houses the transmitter power supply, modulator, and gyro-klystron and incorporates structures to provide a pedestal base for the roof-mounted tracking antenna. A second 20-ft shelter contains the receiver, exciter, signal processing, and recording equipment. Data recording at rates up to 80 MB/s and a capacity of more than 80 GB is available. The transmitter is capable of producing 10 kW of average power with a variety of waveforms suitable for precision tracking and imaging of targets at long range. Waveforms with a bandwidth of 600 MHz can be transmitted at full power. A 6-ft Cassegrain antenna is mounted on a precision pedestal and achieves 62 dB of gain.

CONTACT:
Code 5340.1 • (202) 767-2643
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Radar Test Facility

Radar antennas in front of and on the roof of Bldg. 75

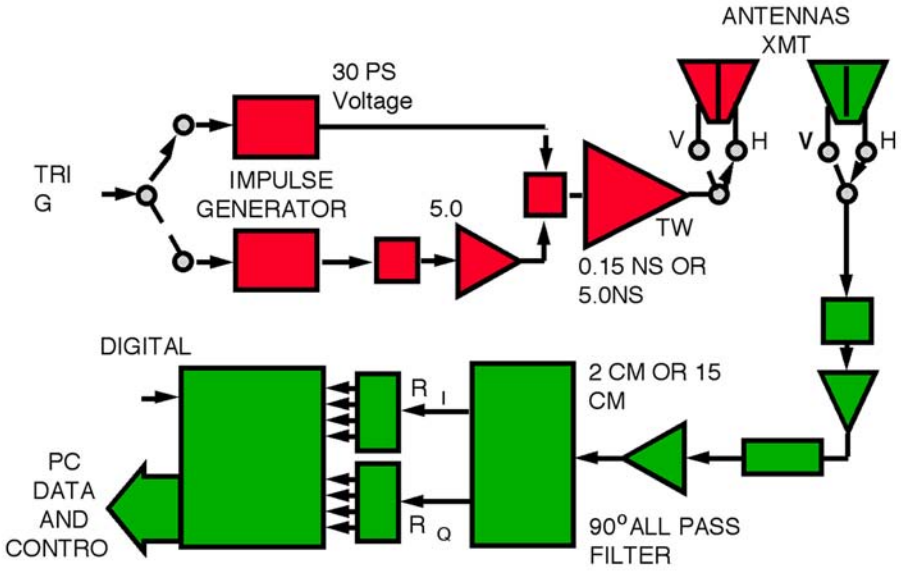
FUNCTION: Tests and evaluates basic concepts and engineering developments in connection with target surveillance, tracking, and electronic countermeasures.

INSTRUMENTATION: Current instrumentation includes the AN/SPS-49 radar; the AN/SPS-55 and AN/SPS-64 navigation radars; the Senrad radar, which uses a wideband array mounted back-to-back with the AN/SPS-50 antenna; and antennas for the AN/SPS-40 and AN/SPS-10 radar systems. In front of the building are two precision tracking pedestals that were originally used for the FPS-16 and TPQ-27 radars but now have been modified for research use. Here also are two mobile research radar systems: the EDM version of the AN/SPQ-9B and the engagement radar, an X-band phased-array radar.

DESCRIPTION: The Radar Test Facility is on top of the cliff in front of Bldg. 75. Antennas are located on the ground and the roof for the numerous developmental and product-line radar systems. They provide a simulated naval scenario overlooking the Chesapeake Bay. Inside the building are the radar control rooms, transmitters, receivers, and data processing equipment.

CONTACT:
Code 5340.1 • (202) 767-2643
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Microwave Microscope (MWM)



Block diagram of Microwave Microscope

FUNCTION: Makes ultrahigh-resolution field measurements. The Microwave Microscope (MWM) has been used in support of several NRL experimental programs involving sea scatter and mine detection.

EQUIPMENT: The MWM consists almost entirely of commercial-off-the-shelf (COTS) equipment. Antenna housings and polarization switching logic were designed and built at NRL.

DESCRIPTION: The MWM, an ultra-wideband, ultra-high-resolution, dual-polarized measurement radar system, has been designed, implemented, and used in the field to measure ocean surface scattering at X-band frequencies. This experimental system uses a video-excited traveling wave tube (TWT) to produce 2-kW peak power transmit pulses as short as 150 ps in duration. Instantaneous receive bandwidths greater than 8 GHz are supported by a unique direct sampling detector that uses off-the-shelf digital sampling oscilloscope components. Data output consists of coherent I and Q measurements in a fixed number of range cells at re-sample periods as short as 25 μs. Final system range resolution is better than 2 cm. The system has been used at a field site at AUTEC, in the Bahamas, to measure ocean surface scatter under high wind and rough sea conditions, and in laboratory buried-object (in sand) identification studies.

CONTACT:
Code 5348 • (202) 404-1876
LOCATION:
NRL, Washington, DC

Information Technology Division

- Mobile Robot Laboratory
- Mobile and Dynamic Network Laboratory
- Integrated Communications Technology Test Laboratory
- General Electronics Environmental Test Facility
- Naval Cryptographic Technology Laboratory
- Naval Key Management Laboratory
- Fleet Information Systems Security Technology Lab
- Navy Shipboard Communications System Test Bed
- Virtual Reality Laboratory
- Ship Motion Simulator Facility
- Motion Imagery Laboratory
- Distributed Center for High-Performance Computing
- Ruth H. Hooker Research Library

Mobile Robot Laboratory

Mobile Robot Laboratory

FUNCTION: Provides an environment for developing and evaluating intelligent software for both actual and simulated autonomous vehicles. Laboratory computers provide a simulated environment for testing intelligent algorithms for land, air, and sea vehicles. The laboratory's several types of indoor and outdoor robot platforms serve as a test bed for robotics applications. The mobile robots are also available as test platforms for sensors, interfaces, and other technologies being developed by groups within NRL.

INSTRUMENTATION: In addition to the robots' autonomous capabilities, communication with stationary host computers is available via a wireless data network and a wireless video system, permitting distributed computing and feedback to remote users. Sensor data and robot performance can be logged onboard or offboard, tailored to the project as arranged by the principal investigator.

DESCRIPTION: The robot laboratory is a 1338-sq-ft facility that allows space for indoor operation of mobile robots and can be configured with obstacles or furniture to simulate expected working environments. A large research support vehicle adds the ability to transport mobile robots to off-site or outdoor worksites, provides its own power, and includes computer workstations for work in the field.

The facility maintains 20 mobile robots widely used in the robotics community, enabling the integration of outside research from other government, academic, and industry laboratories. The robots include models from Nomadic Technologies, iRobot, Segway, and ActivMedia. Researchers can assemble homogeneous or heterogeneous robotic teams, for use in indoor or outdoor environments.

Proprioceptive sensors on the robots include odometry, a pitch/roll/yaw sensor, compass, GPS, inertial position tracker, and tactile bumpers. Onboard rangefinders include sonar, active infrared, scanning laser light detection and ranging (LIDAR), structured light, and stereovision cameras. In addition to the robots' onboard computers, the lab employs Sun workstations, Linux PCs, Windows PCs, and Macs.

CONTACT:
Code 5515 • (202) 767-2684
LOCATION:
NRL, Washington, DC

Mobile and Dynamic Network Laboratory

Mobile and Dynamic Network Laboratory

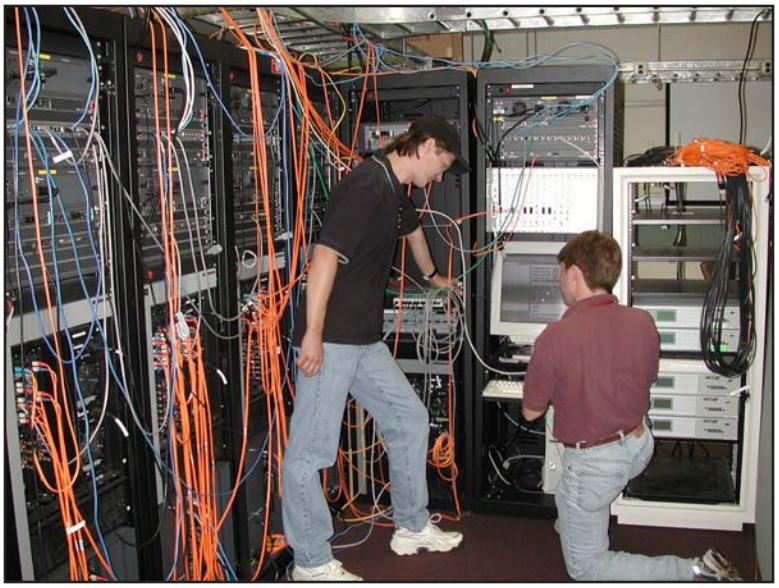
FUNCTION: This facility supports development and evaluation of next-generation communication technologies for mobile and dynamic data networks. This includes wireless and other challenging communication environments relevant to military systems. The laboratory provides for large-scale network simulation, real-time network emulation, and tools to support live field tests of wireless, mobile networks. The facility has provided support for a variety of ongoing NRL, ONR, and DARPA-sponsored projects including cooperative international research in support of coalition networks.

INSTRUMENTATION: The laboratory enables quantitative measurement of protocol and network operation. Software capabilities include dynamic, scriptable traffic generators capable of emulating characteristics of real network communication applications and associated data analysis tools to examine different aspects of communication performance. The laboratory also uses custom data visualization for real time and post-monitoring of network operation in the lab's simulation, emulation, and field test environments. Special hardware instruments such as wireless protocol analyzers are also employed as needed.

DESCRIPTION: The mobile and dynamic network laboratory includes high-performance workstations capable of conducting large-scale simulations of data communication networks, including mobile, wireless scenarios. The facility also has computer systems that are configurable to emulate dynamic, wireless networks in a controlled environment. Mobile networks of more than 20 nodes have been emulated and the system can scale to larger network sizes if needed. The laboratory has laptop computers, hand-held personal computing platforms, and embedded systems to support field testing and demonstration of mobile computing environments including vehicular, man-portable, and autonomous (e.g., sensor) systems. In addition to test applications and tools, the ability to rapidly prototype working advanced protocols and network communication applications is also maintained. Laboratory prototypes are generally instrumented with sophisticated data collection and analysis capabilities. Example implementations include protocols for reliable data transport, real-time communication (including voice, video, and other), collaborative computing, dynamic routing, and network self-configuration and organization.

CONTACT:
Code 5522 • (202) 767-2001
LOCATION:
NRL, Washington, DC

Integrated Communications Technology (ICT) Test Laboratory



Integrated Communications Technology Test Lab

FUNCTION: Provides the capability to perform analysis, testing, and prototype development of high-speed wired and wireless networked data communication systems. It provides connectivity to both classified (SIPRNet) and unclassified (NIPRNet) networks through high-speed Ethernet and asynchronous transfer mode (ATM) interfaces with connections to the Defense Research and Engineering Network (DREN) to facilitate collaborative efforts with other DoD facilities.

INSTRUMENTATION: Test equipment such as network traffic generators and analyzers, signal generators, and spectrum analyzers allow real-time injection and monitoring of wired and wireless traffic flows from simulated and "real world" data sources. Routers, switches, and interface adapters provide reconfigurable connectivity throughout the facility. Test Lab computers running NRL-developed software test programs tailored to meet specific test requirements can assess the performance of military and commercial off-the-shelf (COTS) equipment such as network radios, routers, and communications security (COMSEC) devices. Network performance parameters such as throughput, latency, jitter, and packet error rates are easily measured and documented.

DESCRIPTION: The ICT Test Lab provides a rapidly reconfigurable means to perform testing and evaluation of advanced networking technologies in support of multiple DoD programs such as Fleet Battle Experiments, Joint Forces Command Modeling & Simulation, Joint Experimentation, Joint Task Force (JTF) WARNET, and Dragon Warrior. It is an integral part of the Global Information Grid End-to-End Evaluation Facilities (GIG-EF), and will serve as the Joint Tactical Radio System Wideband Networking Waveform Center of Excellence (JTRS WNW CoE) test facility for government testing of DoD's newest waveform during its development phase. This facility is instrumental in providing the kind of simulation and test environment required to support the research and development of advanced dynamic networking protocols, wireless mobile ad-hoc routing techniques, and bandwidth, power, and quality of service (QoS) management for the Navy's future networking needs.

CONTACT:
Code 5523 • (202) 767-3398
LOCATION:
NRL, Washington, DC

General Electronics Environmental Test Facility

Simulation and Response Measurement Equipment

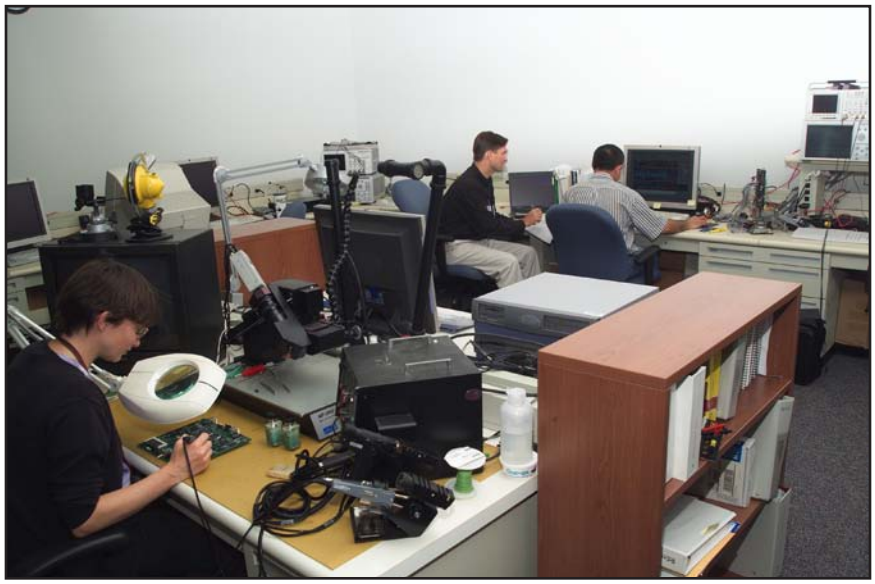
FUNCTION: This facility provides resources for testing the performance and function of electronic equipment under conditions that represent the environment that the equipment could experience during the deployment to and installation in a Naval ship or Marine Corps tactical environment.

INSTRUMENTATION: This includes automated electronic test equipment and instrumentation, phase noise measurement system, noise figure measurement system, precision spectrum analyzers, wide-band signal generators, 40-cubic foot environmental chamber, and an electromagnetic interference (EMI) test chamber located off-site. A variety of additional test equipment including signal generation, signal analysis, and stimulation and response measurement equipment are used in the performance validation of electronic equipment. The suite of equipment provides the ability to test the performance over a variety of environmental conditions that would be experienced in the Navy or Marine Corps.

DESCRIPTION: Several laboratories are available to test electronic equipment to validate the performance under the conditions described in MIL-PRF-28800F. The test conditions defined in MIL-PRF-28800F are designed to replicate the variety of environmental conditions that test equipment could experience when deployed to the Fleet.

CONTACT:
Code 5524 • (202) 767-0327
LOCATION:
NRL, Washington, DC

Naval Cryptographic Technology Laboratory



Naval Cryptographic Technology Laboratory

FUNCTION: As the Navy's corporate Crypto Modernization Laboratory, it provides a secure environment to research and prototype programmable cryptographic technologies for Navy and DoD applications. The lab also allows for development of certifiable Communications Security (COMSEC)/Information Security (INFOSEC) products, including programmable cryptographic devices, cryptographic applications, and high assurance guards.

DESCRIPTION: The Cryptographic Technology Laboratory is a secure environment where COMSEC/INFOSEC research, development, and testing are conducted. Powered by a classified high-performance network of workstations and state-of-the-art development tools, the lab supports development of software, firmware, and hardware. Software stations provide for embedded, real-time software development, including computer-aided software engineering (CASE) tools, embedded integrated development environments (IDE), compilers, debuggers, simulators, emulators, and development boards. Firmware stations provide support for programmable logic design, coding and verification tools for field programmable gate arrays (FPGA), and other programmable logic devices (PLD). Hardware development stations are powered with the Cadence suite of computer-aided engineering (CAE) tools that support schematic capture, digital design and simulations, printed circuit board (PCB) layout, assembly, and testing. The lab is also equipped with a test bed consisting of various end cryptographic units (ECUs) and cryptographic modules used by Fleet systems, useful for interoperability testing.

Code 5541 • (202) 404-4884

LOCATION:

NRL, Washington, DC

Naval Key Management Laboratory

Naval Key Management Laboratory

FUNCTION: As the Navy's corporate key management laboratory, provides a secure environment to research and develop advanced, electronic, key management and networked, key distribution technologies for the Navy and DoD. Also, this lab, in conjunction with the Naval Cryptographic Technologies Lab, serves as a test bed for testing new key management components and key delivery protocols developed for the Electronic Key Management System (EKMS) and the modernized Key Management Infrastructure (KMI).

DESCRIPTION: The Naval Key Management Laboratory is used to develop "networked," key distribution architectures, secure key delivery techniques, and protocols for enhanced key delivery to the warfighter. This lab serves as the development site for the Net Key Management (NKM) system's key server suite, single point keying, and wireless key-fill techniques. Powered by a high-performance network of workstations, servers, databases, network security components, and state-of-the-art development tools, the lab supports development of key management applications and a secure client-server framework for netted key distribution. A secure software development environment provides for J2EE programming, Oracle databases, BEA Weblogic applications, XML programming/guard development, and modeling of advanced protocols for key/data delivery over Ethernet as well as wireless networks. The lab is also equipped with EKMS components (current and prototype models), legacy and next generation key-fill devices, and crypto key material to support interoperability testing and validation of new applications.

CONTACT:
Code 5541 • (202) 404-4884
LOCATION:
NRL, Washington, DC

Fleet Information Systems Security Technology Lab (FISSTL)

Fleet Information Systems Security Technology Lab (FISSTL)

FUNCTION: Provides unique facilities for NRL research into Navy information technology network security. From architectural design, review, and prototyping, to component evaluation and integration, the FISSTL ensures secure capability and availability of Navy network-centric information operations.

INSTRUMENTATION: Senior technical task leaders/principal investigators are responsible for test equipment and system components under development, including protocol analysis tools, vulnerability assessment tools, and network mapping instruments.

DESCRIPTION: The FISSTL has connectivity via the NRL LAN, NIPRNet, and the SIPRNet. Test-bed configurations allow concurrent architectural design testing and evaluation of potential commercial off-the-shelf/government off-the-shelf (COTS/GOTS) security components. Other aspects of the lab facilitate the development of Navy/DoD unique security components and systems.

CONTACT:
Code 5544 • (202) 767-0011
LOCATION:
NRL, Washington, DC

Navy Shipboard Communications System Test Bed

Navy Shipboard Communications System Test Bed

FUNCTION: Provides resources for initial development and testing of new secure voice technologies for Navy shipboard applications.

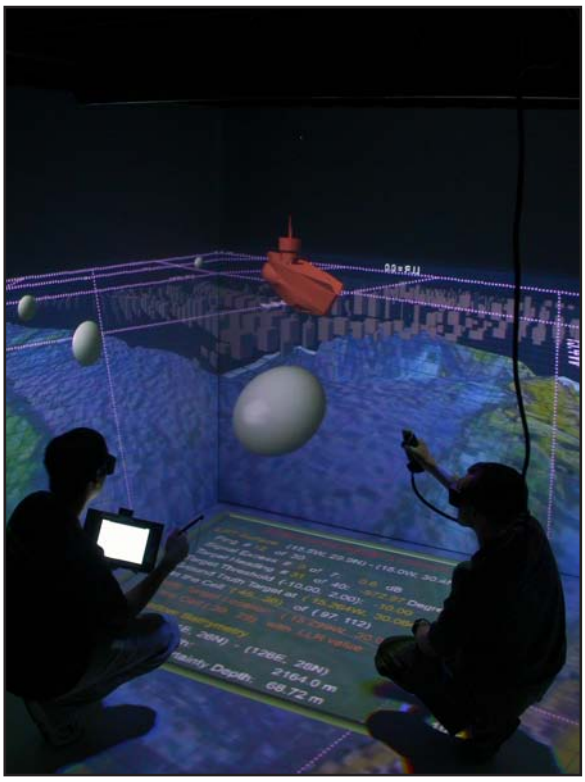
INSTRUMENTATION: The core of the laboratory is the shipboard secure voice installation. This equipment consists of a single audio switch (SAS) 2112 red switch, the associated analog audio-distribution system, which includes red-phone stations and several racks of tactical radios.

The laboratory also contains a Lucent Definity PBX and several stations of digital telephones. Both the red analog and the digital telephony systems are linked to other Navy installations to provide outside connectivity for more extensive testing.

DESCRIPTION: This laboratory consists of a suite of rooms configured with Navy shipboard communications systems. By replicating the tactical communications installations aboard ships, this facility provides the means to perform interoperability testing of emerging communications technologies. It also contains workspaces for the development of both electronic hardware and the various levels of software (embedded to application level) that typically comprise communications devices.

CONTACT:
Code 5555 • (202) 767-2157
LOCATION:
NRL, Washington, DC

Virtual Reality (VR) Laboratory



The Virtual Reality Laboratory

FUNCTION: Performs basic and applied research in virtual reality (VR), augmented reality (AR), and interactive 3-D computer graphics. The VR Laboratory is also used to visualize scientific data sets and to perform research into visualization techniques.

DESCRIPTION: The VR Laboratory includes an Immersive Room (the GROTTO); two VR Responsive Workbenches; head-mounted displays; two PC clusters; one of which is used to drive GROTTO display; additional graphics workstations; and 3-D audio and voice-recognition packages. Our augmented reality hardware suite includes wearable computers, optical see-through displays, vision- and nonvision-based tracking hardware, and GPS and inertial sensors. Haptic devices for studying the role of touch in man-machine interaction include a CyberGrasp/CyberForce and a Phantom.

The Immersive Room, sometimes known in the literature as a "CAVE," is a 10 × 10 × 9-ft room on which stereo images are projected onto three walls and the floor, allowing users to feel as though they are inside the virtual environment. Using a 3-D joystick, the user navigates through the virtual scene (e.g., a ship, a scientific data set). The augmented reality systems allow multiple users to go outdoors and see augmented information (e.g., street names, routes, phase lines) placed directly on top of the real world using the heads-up, see-through, optical displays. A 3-D command center, simulated by the GROTTO and Workbench, allows real-time updates of information and mission-specific goals to be sent to the mobile users.

CONTACT:
Code 5580.1 • (202) 767-5333
LOCATION:
NRL, Washington, DC

Ship Motion Simulator Facility

Ship Motion Simulator Facility

FUNCTION: Provides a regional facility for conducting research under conditions of simulated shipboard motion. Research areas include the impact of shipboard motion upon engineering systems and sensors and the impact of shipboard motion upon human performance, particularly with respect to the interaction between human operators and sophisticated computer interfaces. This facility provides a cost-effective means for conducting such studies.

DESCRIPTION: NRL has owned and operated a ship motion simulator since 1943. Originally developed to provide gunnery practice for sailors, the ship motion simulator has been used more recently to test radar and satellite receiving systems. Under sponsorship of the Office of Naval Research, an operations van has recently been attached to the reinforced upper deck of the ship motion simulator. The van can accommodate five to six experimenters and subjects. A heating/cooling unit maintains uniform climate control. Shelves, desks, and work areas provide adequate space for computer monitors and support hardware. A permanent intercom system provides continuous communication between the occupants of the van and the ship motion simulator operators. Different motion scenarios can be designed and run as required. Hourly operating costs are low.

CONTACT:
Code 5583 • (202) 404-7332
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Motion Imagery Laboratory (MIL)

Motion Imagery Laboratory

FUNCTION: Supports research in leading edge progressive-scan imaging, high-definition television (HDTV), technology needed to process very-high-resolution images, and the impact on human perception with various presentation and image capture techniques.

DESCRIPTION: The MIL is a research environment that leverages high-end computational assets and networks in close association with applications to take advantage of leading edge capabilities in state-of-the-art motion imagery with progressive scan HDTV. The MIL is working with imagery requirements in the near-term where multiple 1.5-Gbps data streams are needed to handle the raw output and to progress to 40 Gbps and higher in the near future.

The MIL at NRL includes projection facilities for very-high-definition immersion with surround screens, extremely high-resolution micromirror projection, progressive-scan studio cameras, recording/replay capabilities, and other tools for comprehensive work in this area. The MIL is used to assess innovative techniques in next-generation video teleconferencing. Research efforts are conducted as to the collective issues of large single streams on gigabit networks over very long distances in real time and the visual tools to support next-generation motion imagery capabilities. The MIL provides an environment to assess collaboration in intelligence, digital Earth model, test and evaluation, and other DoD needs where very-high-resolution imagery would have an impact. The MIL supports work in compression technology, processing, transmission, and other technologies to allow access to high-resolution imagery across the spectrum of users from average users at their desktops to the most demanding scientific and analytic needs.

CONTACT:
Code 5590.3 • (202) 404-7028
LOCATION:
NRL, Washington, DC

Distributed Center for High-Performance Computing

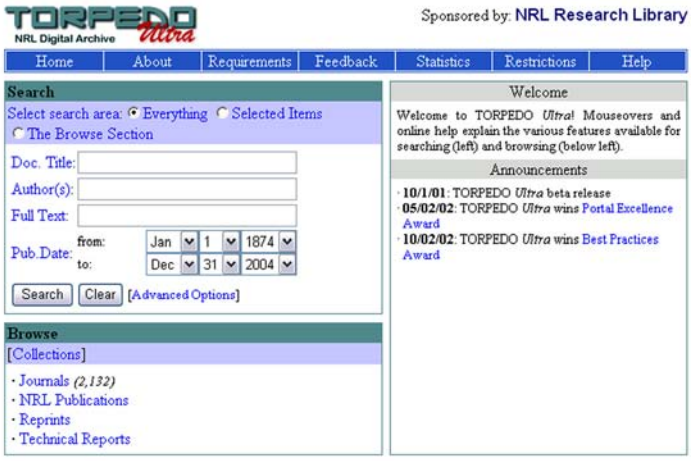
Distributed Center for High-Performance Computing

FUNCTION: As a Distributed Center (DC) in the DoD High-Performance Computing Modernization Program (HPCMP), NRL's Center for Computational Science supports leading edge introduction of high-performance computing to DoD. The Center makes available a range of shared resources, including massively parallel computer systems and high-performance networks to NRL, Navy, and DoD scientific users.

DESCRIPTION: NRL's DC in the HPCMP supports the introduction of a variety of leading-edge technologies in high-performance computing (HPC). The HPC work includes the introduction or extension of new architectures such as cache-coherent Non-Uniform Memory Access (cc-NUMA), and Multi-Threaded Architectures (MTA) where the application requires access to global shared memory and large single images to achieve results. Research on the high-end computational assets and networks results in close association with applications that demand these leading edge capabilities. The Center not only operates and maintains leading edge super computers from Silicon Graphics (SGI) and others, but supports the scientific users in porting their code to and using these high-end assets. User support includes both the computing assets at NRL as well as HPCMP assets at 20 other locations across DoD. The Center also has more than 12.5 terabytes of online shared rotating disk and robotic storage systems for fileserving and archiving that currently holds 350 terabytes of multimedia data and is scalable to over a petabyte. HPC research extends to the high-performance networks needed for true distributed computing, including the Defense Research and Engineering Network (DREN) and the Advanced Technology Demonstration network (ATDnet). The networking efforts include transparent and ubiquitous computing, security and work in dense wave division multiplexing (DWDM), and switching in optical networks.

CONTACT:
Code 5594 • (202) 767-3885
LOCATION:
NRL, Washington, DC

Ruth H. Hooker Research Library



TORPEDO *Ultra*, one of the Web-based services available through the NRL Research Library

FUNCTION: The NRL Research Library offers a full range of traditional and digital library services to enhance and support the research program of the Naval Research Laboratory. Traditional library services include a physical facility for study and research, staffed with subject specialists and information professionals, to assist researchers in locating and retrieving published information. A rich and extensive journal, technical report, and book collection is available that has been created and maintained over the 75+ year history of the library. To enhance traditional services, the library is also actively developing the NRL Digital Library (http://infoweb.nrl.navy.mil), which provides access to thousands of journals, books, and reference sources, to desktops at NRL-DC, NRL-Stennis, NRL-Monterey, or the Office of Naval Research.

EQUIPMENT: Public access computers, photocopiers, color printer, microform reader/printers, and self-service digital sender.

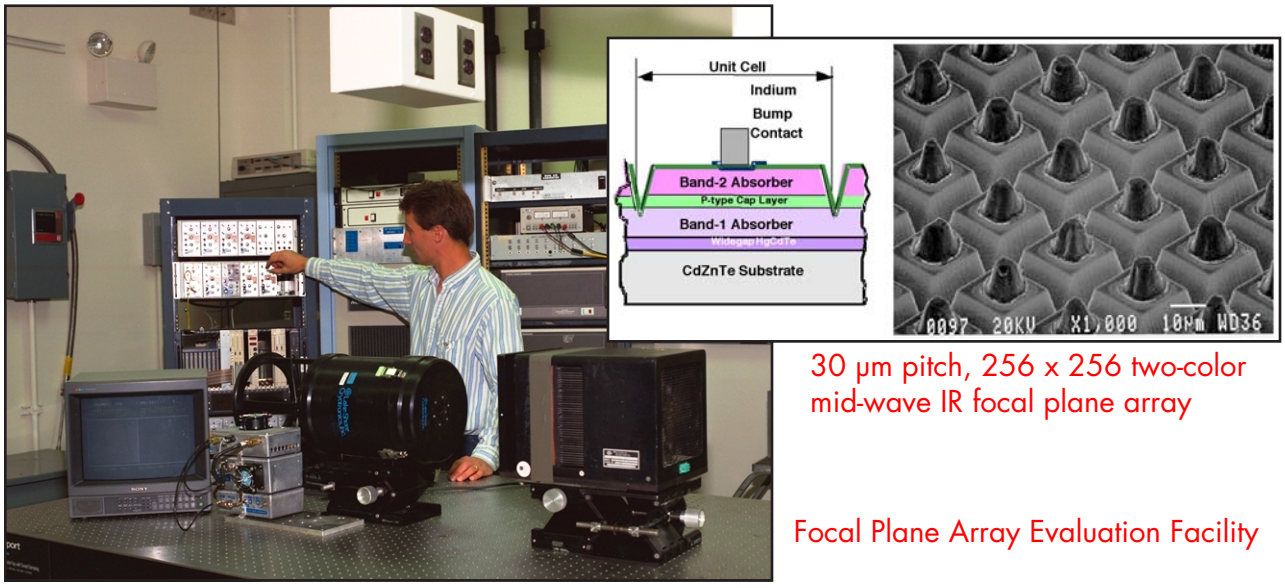
DESCRIPTION: The Library collections focus on physics, chemistry, electronics, and space sciences. They include 150,000 books and journal volumes, 3,000 current journal subscriptions, and nearly 2 million technical reports in paper, microfiche, or electronic format. The contents of the Library's collections are regularly analyzed, organized, and updated to provide quick and easy retrieval of the most appropriate items. Services include: reference assistance in using the collections and locating information from external sources; mediated literature searches of several hundred online databases, including classified databases, to produce on-demand subject bibliographies; circulation of materials from the collection including classified literature up to the SECRET level; interlibrary loan—to obtain needed items from other scientific and research libraries or from commercial document providers; ordering all journals for office retention; and user education and outreach to help researchers improve productivity through effective use of the physical library and the rapidly growing Digital Library resources available through InfoWeb, TORPEDO *Ultra*, and the World Wide Web. The "portal" to the NRL Digital Library is called InfoWeb. It provides desktop access to thousands of research journals and hundreds of technical databases and reference tools including Science Citation Index (part of Web of Science) and INSPEC. A key InfoWeb service is TORPEDO *Ultra* v.2 which hosts thousands of licensed journals and thousands of NRL publications, such as technical reports, press releases and NRL-authored journal articles/conference proceedings.

CONTACT:
Code 5596 • (202) 767-2357
LOCATION:
NRL, Washington, DC

Optical Sciences Division

- Focal Plane Array Evaluation Facility
- Fiber Fabrication Facility for Nonoxide and Specialty Glasses
- Nanochannel Glass Technology Facility
- Organic Opto-Electronics Fabrication and Characterization Facility
- Fiber-Optic Optical-Microwave Laboratory
- IRCM Techniques Laboratory
- Missile Warning System Facility
- Infrared Range Facility
- Fiber-Optic Sensor Facility
- Oxide Optical Fiber Fabrication Facility

Focal Plane Array Evaluation Facility



30 µm pitch, 256 x 256 two-color mid-wave IR focal plane array

Focal Plane Array Evaluation Facility

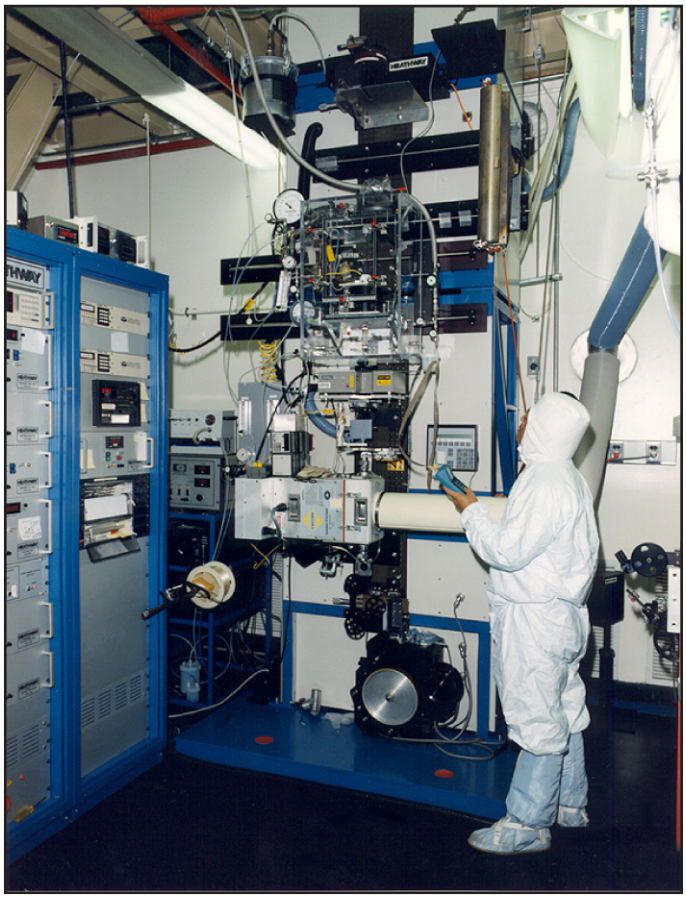
FUNCTION: Evaluates the performance and potential of prototype focal plane arrays (FPA) to fulfill Navy sensor requirements, both optical and electrical. Determines the development status of the FPAs and provides foundation for guidelines for future development contracts.

INSTRUMENTATION: The facility has extensive automated capabilities to measure the optical and electrical characteristics of FPAs being developed for advanced Navy sensors. The facility includes clocking and drive electronics to operate the multiplexers on the array, calibrated continuous and pulsed infrared sources, electronics for video signal processing and digitization, and computer data reduction and display. It also includes image processing equipment to analyze algorithms for correcting non-uniformities in array response, to control signal processing within the focal plane, to provide real-time visualization of imagery from multispectral arrays, and to generate/enhance spatial resolution video from image sequences.

DESCRIPTION: The automated FPA evaluation facility consists of optical sources, signal generation and processing electronics, and data acquisition and analysis processors that are required to evaluate visible and infrared multispectral FPAs, comprised of optical sensing elements coupled with signal multiplexing and processing electronics in a single microchip. Advanced signal and image analysis hardware and software are available to test and demonstrate 3-D readout architectures and circuits that enable sophisticated, multifunction signal processing directly beneath and within the available footprint defined by individual detector pixels in staring 2-D FPAs. Since developmental arrays are often received in chip format, a variety of dewars and mounts are available to accept different chip carriers. Optical sources are used to illuminate the detectors with short pulses or continuous radiation in both uniform and single detector modes. Calibrated laser sources are used to study array performance under optical overload conditions. The data are acquired, processed, displayed, and stored using computer techniques, because each array may consist of millions of detectors, and many samples are required for statistical significance. Optical filters and spectrometers are used to provide photons within multiple spectral bands.

CONTACT:
Code 5661 • (202) 767-2225
LOCATION:
NRL, Washington, DC

Fiber Fabrication Facility for Nonoxide and Specialty Glasses



Fiber Fabrication Facility for Nonoxide and specialty glasses

FUNCTION: Unique facility for the research, development, and fabrication of nonoxide and specialty glasses and fibers in support of Navy/DoD programs.

INSTRUMENTATION: Equipment is available for characterization of glass physical, thermal, and optical properties. Infrared (IR) lasers and spectrometers are routinely used for fiber characterization.

DESCRIPTION: Three Class 100 clean rooms, covering approximately 1500 ft^2, contain several fume hoods and inert gas dry-boxes for chemical handling. Resistance furnaces and RF induction furnaces are used for chemical purification and glass melting. Two state-of-the-art draw towers are used for fabricating fiber from specialty glasses under controlled atmospheres using distinctly different techniques, namely, preform and double crucible processes, respectively. The fibers fabricated at this facility possess low loss, high strength, and high threshold to laser damage and are enabling many Navy/DoD applications.

CONTACT:
Code 5606 • (202) 767-5836
LOCATION:
NRL, Washington, DC

Nanochannel Glass Technology Facility

Nanochannel glass draw towers housed in a Class 100 clean room

FUNCTION: Provides for the fabrication of nanochannel glass, a specialized composite glass material that has regularly spaced features, on a nanometer-size scale. Nanochannel glasses are used in the fabrication of nanocomposite and nanopatterned materials.

INSTRUMENTATION: The Nanochannel Glass Technology Facility is fully equipped to address all aspects of fabrication, processing, and characterization of nanochannel glass. Specific instrumentation available at the facility includes:

- An18-ft draw tower contained in a Class 100 clean room
- Computer control of down feed, furnace temperature, and pinch wheels
- Optical microscopes
- Atomic force microscope
- Thermal analysis instrumentation (thermogravimetric analyzer (TGA), thermomechanical analyzer (TMA), and differential scanning calorimeter (DSC)) wafering, grinding, and polishing equipment.

DESCRIPTION: The Nanochannel Glass Technology Facility includes a state-of-the-art, fully automated, glass-fiber draw tower. This draw tower is specially equipped to permit the drawing of multielement fiber bundles. Nanochannel glasses are fabricated by first stacking thousands of composite glass fibers together in hexagonal-shaped bundles. These multielement bundles are drawn, using the draw tower, into boules that contain parallel arrays of fused nanometer-scale fibers or channels. The nanochannel glass boules are processed by slicing the boules into wafers that are subsequently etched, ground, polished, and characterized.

CONTACT:
Code 5611 • (202) 767-9468
LOCATION:
NRL, Washington, DC

Organic Opto-Electronics Fabrication and Characterization Facility

Organic Opto-Electronics Fabrication and Characterization Facility

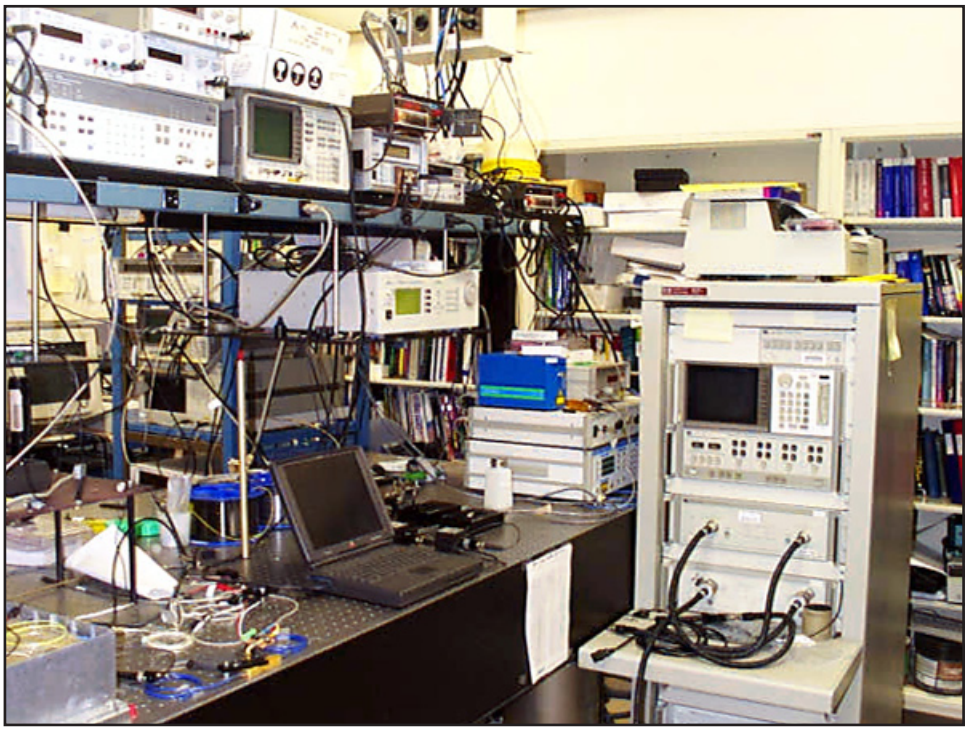
FUNCTION: Prepares and spectroscopically characterizes electro- and photo-active organic thin films. Fabricates and evaluates the performance of organic electro-optic, opto-electronic, and electronic devices such as light-emitting diodes, solar cells, and field-effect transistors.

INSTRUMENTATION: A versatile high-vacuum multi-surface film deposition apparatus is available for the preparation of organic films and devices. The chamber encloses a large, temperature-controlled (10-450 K) wheel that holds 14 substrates and four-quartz crystal microbalances, and up to eight resistive heating furnaces for high-vacuum deposition. A Spex 270M monochromator outfitted with a liquid nitrogen cooled charge-coupled device (CCD) detector is used for spectroscopic characterization. A computerized, controlled atmosphere experimental chamber equipped with a freezer and a microscope is available for handling sensitive chemicals, fabrication, and characterization of prototype devices. The chamber houses several pieces of equipment such as an integrating sphere and a luminance meter for material and device characterization. A newly built ultrahigh-vacuum (UHV) multi-chamber deposition apparatus, interfaced to a controlled atmosphere chamber, is available for device fabrication (up to 5 in. diagonally) and sealing. This chamber will be soon moved and housed in a clean room at the Nanoscience Institute Building.

DESCRIPTION: A state-of-the-art fabrication and characterization facility is available for the development of organic electro-optic, opto-electronic, and electronic prototype devices such as light-emitting diodes, solar cells, and field-effect transistors. Devices are prepared by sequential vacuum vapor deposition of organic and inorganic films on glass or flexible substrates. The deposition processes take place in separate adjacent chambers connected by gate valves. The samples are either rotated from one position to the next, or moved horizontally via magnetic arms. Spectroscopic characterization can take place in situ in vacuum and/or ex situ in a controlled-atmosphere chamber. The facility also provides capabilities for the growth and spectroscopic characterization of high quality electro- and photo-active organic thin films.

CONTACT:
Code 5615 • (202) 767-9529
LOCATION:
NRL, Washington, DC

Fiber-Optic Optical-Microwave Laboratory



Fiber-Optic Optical-Microwave Laboratory

FUNCTION: Used to conduct programs of basic science and applied research in the development of laser sources, high-power fiber amplifiers, photonic control of phased arrays, antenna remoting, and microwave frequency conversion.

INSTRUMENTATION: The laboratory equipment includes an extensive array of microwave and optical test equipment. Optical and microwave components used in the lab are primarily commercially available and represent the state-of-the-art in microwave photonics technology.

DESCRIPTION: The laboratory is equipped with state-of-the-art microwave and millimeter wave (MMW) components along with a wide variety of fiber- and free-space optics. Microwave photonics derives its strength from the merger of microwave and fiber-optic techniques for the development of systems with greater than 100 GHz of operational bandwidth. This merger has enabled the development of photonic links for low-loss antenna remoting, true-time delay for squint-free beam steering, microwave frequency conversion, low-noise optical transmitters, and highly efficient photodetectors. In addition, the optical and microwave components used in these systems are commercially available and are improving with advances in the telecommunications industry. Research equipment includes a wide variety of microwave and optical test instruments and components enabling the development of optical techniques valuable for future Navy capability.

CONTACT:
Code 5650 • (202) 767-9360
LOCATION:
NRL, Washington, DC

IRCM Techniques Laboratory

Open loop rate table for hardware IRCM testing

FUNCTION: Assists the Navy and Marine Corps in the development of infrared countermeasure (IRCM) technology and techniques for Fleet aircraft protection. Specifically, determines requirements for IRCM techniques to defeat infrared threats, imaging and reticle-based surface-to-air and air-to-air IR missiles and forward-looking infrared (FLIR) devices. IRCM technologies and techniques include sensor damage, coherent and incoherent jamming, and expendable/flares.

INSTRUMENTATION:

- Two open-loop rate tables for IRCM testing of reticle and imaging IR seekers
- A 64-channel analog data acquisition system
- Three multiprocessor simulation workstations – SPARC, ALPHA, and MIPS machines
- One SGI 8-processor simulation supercomputer.

DESCRIPTION: The IRCM Techniques Laboratory performs open-loop hardware testing of "real" missile/sensor threat seekers as well as all-digital missile modeling and simulation analysis to determine countermeasure requirements to defeat the IR threat. The laboratory provides a comprehensive test bed for all types of IR countermeasures against a variety of IR threats. The facility includes advanced countermeasure sources for the testing of directed IRCM/advanced threat IRCM (DIRCM/ATIRCM) style countermeasure systems and a two-color multiflare/expendable hardware simulator for testing advanced expendable techniques against multispectral threats. The laboratory also has an extensive modeling and simulation capability for testing of IRCM against both reticle-based and IR focal plane array-based missile seekers.

CONTACT:
Code 5660.2 • (202) 767-2115
LOCATION:
NRL, Washington, DC

Missile Warning System Facility

Missile Warning System Facility

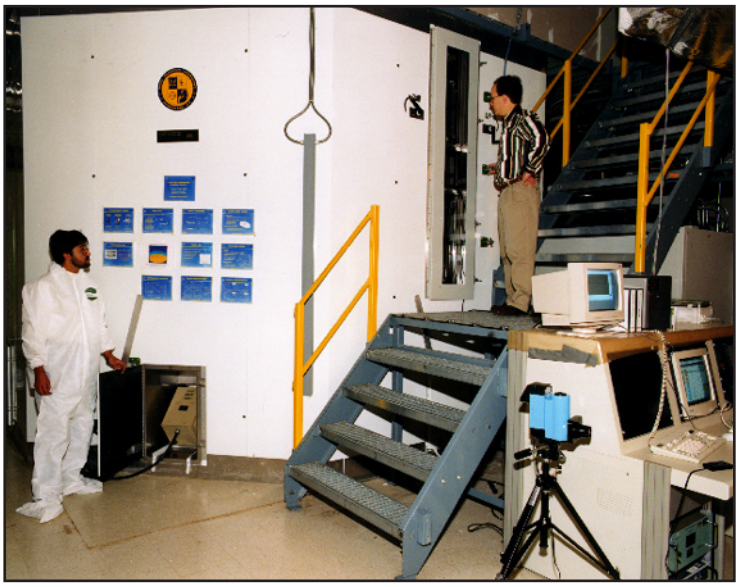
FUNCTION: Operates a classified facility for research projects dedicated to the development of missile warning systems for the self-protection of Naval aircraft. Participates in exploitation measurements of missile signatures. Simulates the acquisition, guidance, and aerodynamic performance of threat missiles. Measures and models sensor responses to threat signatures as well as the performance of detection and declaration algorithms.

INSTRUMENTATION: Principal instrumentation consists of a network of computer workstations capable of hosting both system data and the required system software simulations.

DESCRIPTION: An extensive database of threat and background clutter signatures is maintained for developmental and fielded self-protection systems. Participation in field tests (missile live firings and overflights) ensures the data's relevance to the developmental effort. Simulations of threat missile engagements along with simulations of system hardware permit predictions of system performance. Recent activities include support for the AN/AAR-47 Missile Warning Set and the NRL Tactical Aircraft Directed Infrared Countermeasures (DIRCM) System.

CONTACT:
Code 5663 • (202) 767-9530
LOCATION:
NRL, Washington, DC

Infrared Range Facility



Infrared Range Facility

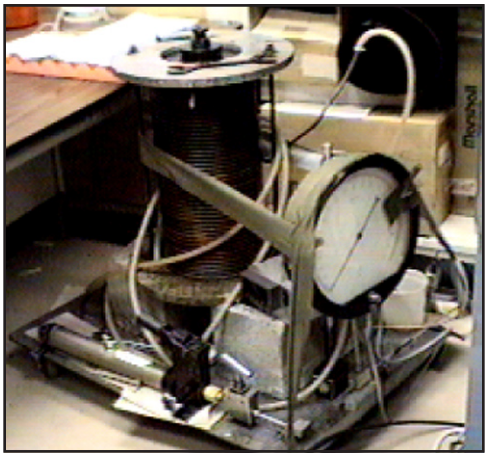
FUNCTION: Enables scientists to measure the infrared (IR) signature of scale aircraft or ship models in a controlled environment, to test the effectiveness of new signature suppression coatings, and to validate IR signature codes against range imagery. Simulates the IR environment from sea level to 30-kft altitudes, and provides viewing angles representative of standard IR threats, versatile control of scale model temperatures and orientations, and a low-cost alternative to IR field testing.

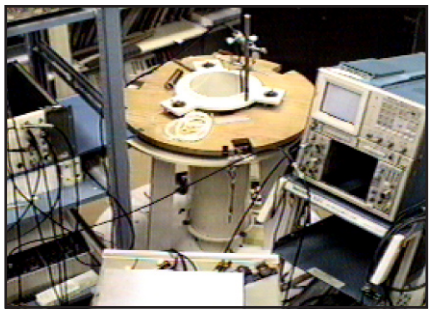
INSTRUMENTATION: State-of-the-art focal plane array cameras, low-temperature blackbodies, hemispherical directional reflectometers, and laser-based scatterometers for measuring the bidirectional distribution function.

DESCRIPTION: The NRL Infrared Range Facility is a unique national user facility that serves the IR signature community. The range is a 14-ft diameter, temperature-controlled, cylindrical enclosure that is treated with high emittance coatings on the inner walls. The enclosure is surrounded by a 20-ft diameter thermal chamber. Test articles are inserted through the roof of the chamber and can be viewed over a range of elevation angles from –20 deg to +45 deg. The test article itself can be rotated through ±180 deg, tilted through ±45 deg, and temperature-controlled through a variety of heaters and temperature conditioned fluids. A midwave infrared (MWIR) source is available for semiquantitative solar simulations. The dry air atmosphere within the chamber has a dew-point of approximately –70 °C and a CO_2 level of below 1 PPM. Low CO_2 levels are needed to minimize absorption in the CO_2 absorption doublet near 4.2 μm. The low dew-points are needed to minimize frost formation on the chamber walls when configured for high-altitude conditions (long wavelength infrared (LWIR)). The chamber walls used to simulate the zenith sky can attain temperatures as low as –110 °C. The sky panels are coated with a new type of flocked black coating with a hemispherical reflectance below 0.2% throughout the IR. Without such a coating, the thermal radiation from the warm Earth panels would reflect from the sky panels and overwhelm the emitted radiation from the sky.

CONTACT:
Code 5664 • (202) 404-7308
LOCATION:
NRL, Washington, DC

Fiber-Optic Sensor Facility





Fiber-Optic Sensor Facility

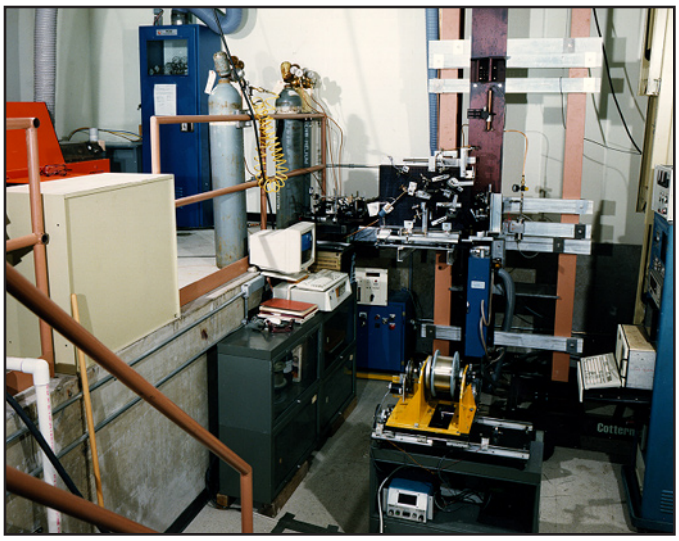
FUNCTION: Constructs and evaluates fiber-optic sensors for a variety of measurands. These measurands include acoustic, pressure, magnetic, and electric field as well as strain and rate of rotation.

INSTRUMENTATION: The facility uses seven Hewlett Packard 3562A and three Hewlett Packard 3582A dual-channel spectrum analyzers, one Hewlett Packard 3567 modular three-channel spectrum analyzer, three Tektronix single-channel spectrum analyzers, two HP 89410 network analyzers, three TEAC RD-200T 16-channel digital audio-tape recorders, and one RX-800 32-channel DAT recorder. Other instrumentation include an Anritsu MS 9710B Optical Spectrum Analyzer and an HP 8509B Lightwave Polarization Analyzer.

DESCRIPTION: The sensor construction facility includes two Accuwinder coil winding machines, seven optical fiber fusion splicers, annealing facilities for magnetic materials, and facilities for degassing adhesives for potting purposes. The evaluation facilities include two computer-controlled data reduction and analysis stations, one optimized for acoustic sensors and the other optimized for magnetic sensors. There are two environmental chambers that operate from –50° to 100 °C for life testing of prototype sensors. The acoustic sensor evaluation facility also includes a pressure chamber for determining dc acoustic sensitivity as well as crush performance of prototype fiber-optic hydrophone designs (see left figure above). Also available is a G-40 shipboard calibrator, which can operate over a 5 to 1000 Hz frequency range at ambient pressure and between 4° and 35 °C (see right figure above). The evaluation facility for rate of rotation sensors includes a Contraves rate table (1,000 deg/s to Earth rate) and a suite of measurement equipment. The evaluation facility for magnetic sensors includes mumetal magnetic shields for low noise measurements and an automated system for dynamic magnetization and Barkhausen noise measurements. The facility has optical test equipment to evaluate optical sources as well as an Optical Time Domain Reflectometer (OTDR) and a Status Monitoring and Reliability Test System (SMARTS) to evaluate fiber-optic circuitry. A number of optical sources at 1.3 and 1.5 μm wavelengths (including a tunable source) are also available.

CONTACT:
Code 5674 • (202) 767-1316
LOCATION:
NRL, Washington, DC

Oxide Optical Fiber Fabrication Facility



Fiber draw tower showing excimer laser and UV interferometer for fabrication of fiber Bragg grating arrays in line during fiber drawing

FUNCTION: Fabricates unique state-of-the-art optical fibers based on pure or doped silica glass systems. It has the capability of fabricating both single-mode and multimode fibers doped with germanium, phosphorus, and fluorine and holey fibers containing photosensitive and/or laser active elements. In addition, it can fabricate fibers with cores doped with high concentrations of laser-active ions such as erbium, ytterbium, and neodymium, together with aluminum. The facility supports Navy and DoD programs in fiber-optic sensing, nuclear radiation hardness, optical limiting, fiber-optic tethers, high-power fiber lasers, and small fibers with low visibility.

INSTRUMENTATION: In the Preform Fabrication Laboratory, the reagent gases and rare Earth chelate delivery systems are electronically metered. Deposition temperature and preform diameter are monitored, and a computer provides closed-loop control by varying torch temperature and exhaust back pressure. During drawing, the fiber diameter and coating concentricity are monitored with laser-based optical instruments. A noncontact instrument measures draw tension. In the grating writing process, the Bragg wavelength is computer controlled, and the computer also synchronizes the draw process with the firing of the pulsed ultraviolet (UV) laser to determine the spacing of the gratings along the fiber. The grating positions are marked with an ink-jet bar code printer.

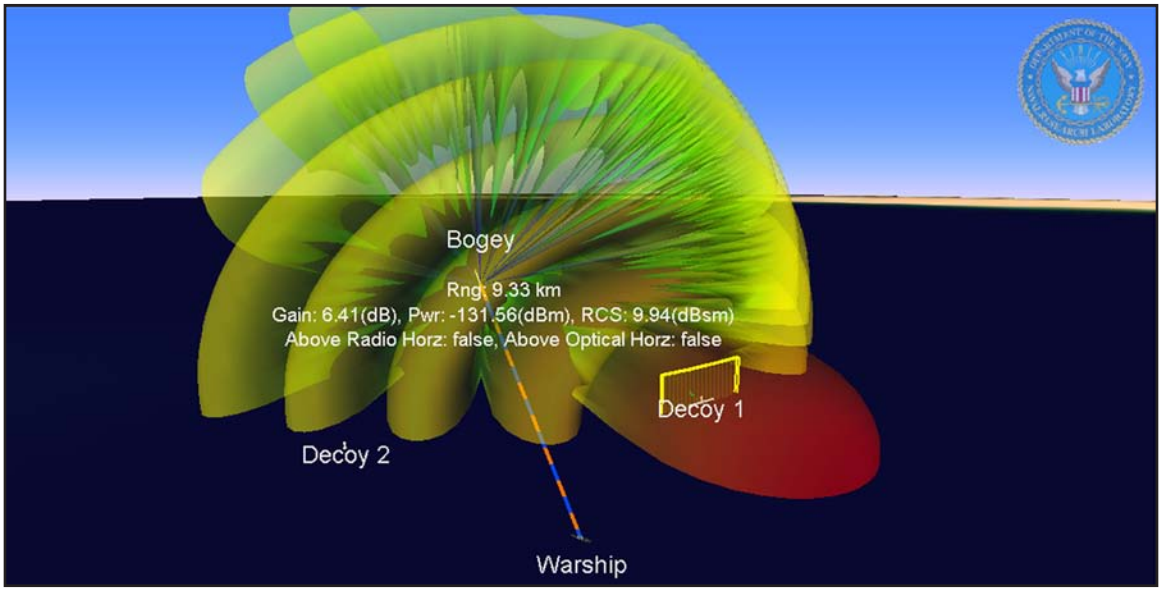
DESCRIPTION: The facility consists of two parts: the Preform Fabrication Laboratory and the Fiber Draw Laboratory. In the Preform Fabrication Laboratory, optical fiber preforms are fabricated using the modified chemical vapor deposition process. The optical cladding and core are deposited layer by layer, and then the preform is collapsed into a solid rod whose refractive index profile and core/clad ratio are preserved in fiber drawing. In the Fiber Draw Laboratory, the preform is slowly lowered into a high-temperature furnace at the top of the 24-ft draw tower. The glass softens and the optical fiber is drawn out of the bottom of the furnace, and the fiber diameter and draw tension are monitored using noncontact techniques. Fiber Bragg gratings may be written into the fiber with short pulses of UV light from an excimer laser. The fiber is coated with a polymer to protect its surface and preserve its intrinsic strength.

CONTACT:
Code 5675 • (202) 767-2270
LOCATION:
NRL, Washington, DC

Tactical Electronic Warfare Division

- Visualization Laboratory
- Transportable Step Frequency Radar
- Vehicle Development Laboratory
- Offboard Test Platform
- Compact Antenna Range Facility
- Isolation Measurement Chamber Facility
- RFCM Techniques Chamber Facility
- Search Radar ECM/EA Simulator
- Low-Power Anechoic Chamber
- High Power Microwave Research Facility
- Electro-Optics Mobile Laboratory
- Infrared/Electro-Optical Calibration and Characterization Laboratory
- Infrared Missile Simulator and Development Laboratory
- Secure Supercomputing Facility
- CBD/Tilghman Island IR Field Evaluation Facility
- Ultra-Short Pulse Laser Effects Research and Analysis Laboratory
- Central Target Simulator Facility
- Flying Electronic Warfare Laboratory

Visualization Laboratory



Visualization Laboratory

FUNCTION: Evaluates and improves the operational effectiveness of existing and emerging electronic warfare (EW) systems. By analyzing and visualizing the results of scenarios, the requirements in design, tactics, and training are addressed.

INSTRUMENTATION: The Visualization Laboratory is equipped with advanced computer graphics workstations, software tools, a large video wall measuring approximately 150 in. × 42 in., and surround sound. A Linux cluster and workstations consisting of Linux, Silicon Graphics, Solaris, and Windows operating systems are used for software development and testing to interactively design and visualize simulations.

DESCRIPTION: The Visualization Laboratory evaluates and improves the operational effectiveness of existing and emerging EW systems. By analyzing and visualizing the results of scenarios, the design, tactics, and training are assessed. 3-D computer graphics are used to display parameters in an intuitive manner, providing depth, volume, and spatial information. Several analysis routines exist to review the static and dynamic components of the simulation. Static analysis tools convey attributes such as number of platforms, missiles, and emitters used with the scenario, the location of emitters on various platforms, and their characteristics. Dynamic analysis tools convey information about time-variant components, the number of detectable emitters, their bearing, and operation mode. High-resolution imagery overlaid on digital elevation data is used to provide an accurate representation of the geographical areas. Live data sources and multimedia interfaces to naval platform and Geospatial Information System (GIS) databases also exist.

CONTACT:
Code 5707 • (202) 767-2897
LOCATION:
NRL, Washington, DC

Transportable Step Frequency Radar (TSFR)

Transportable Step Frequency Radar

FUNCTION: Provides a mobile facility to characterize and quantify the radar cross section (RCS) signature of ships and electronic warfare (EW) passive and active systems over 8 to 18 GHz band and at 35 GHz. Additionally, the system can measure the Effective Radiated Power (ERP), sensitivity, and other target signature characteristics of ships, and active or passive EW systems over the same frequency range.

INSTRUMENTATION: The instrumentation radar digitizes and stores on a pulse-by-pulse basis coherent data for a target of interest for post-test data processing. Effective radiated power (ERP), RCS data, sensitivity and other target characteristics are collected using fast analog-to-digital converters (ADCs), data collection and storage systems. Data processing is very flexible, and can be supplied in predetermined processing and display formats or the processed data can be tailored to user requirements. The instrumented data radar is calibrated by using a combination of automated internal and external procedures.

DESCRIPTION: The facility consists of an I-band tracking radar, an optical designator to aid in target acquisition, a dual 1-kW, broadband, traveling-wave-tube-based radar for ERP, RCS, sensitivity and other target characteristic measurements. Similar measurements can be made with the 35 GHz radar. Radar parameters such as pulse repetition frequency, pulse width, frequency, transmit polarization, and receive polarization are programmable. Measurements can be made with a selectable transmit polarization and received with pulse-by-pulse switched received polarization or dual received polarizations basis if required. The complete self contained system is controlled from up to three operator workstations in an 8 × 24-ft instrumentation hut with all required antennas, cooling, and generator power mounted on a 45-ft trailer that can be moved to any test range where measurements are to be made.

CONTACT:
Code 5710 • (202) 404-7691
LOCATION:
NRL, Washington, DC

Vehicle Development Laboratory

More than 200 prototype vehicles have been developed in the Vehicle Development Laboratory.

FUNCTION: Supports the development of prototype deployment platform vehicles for offboard countermeasure systems.

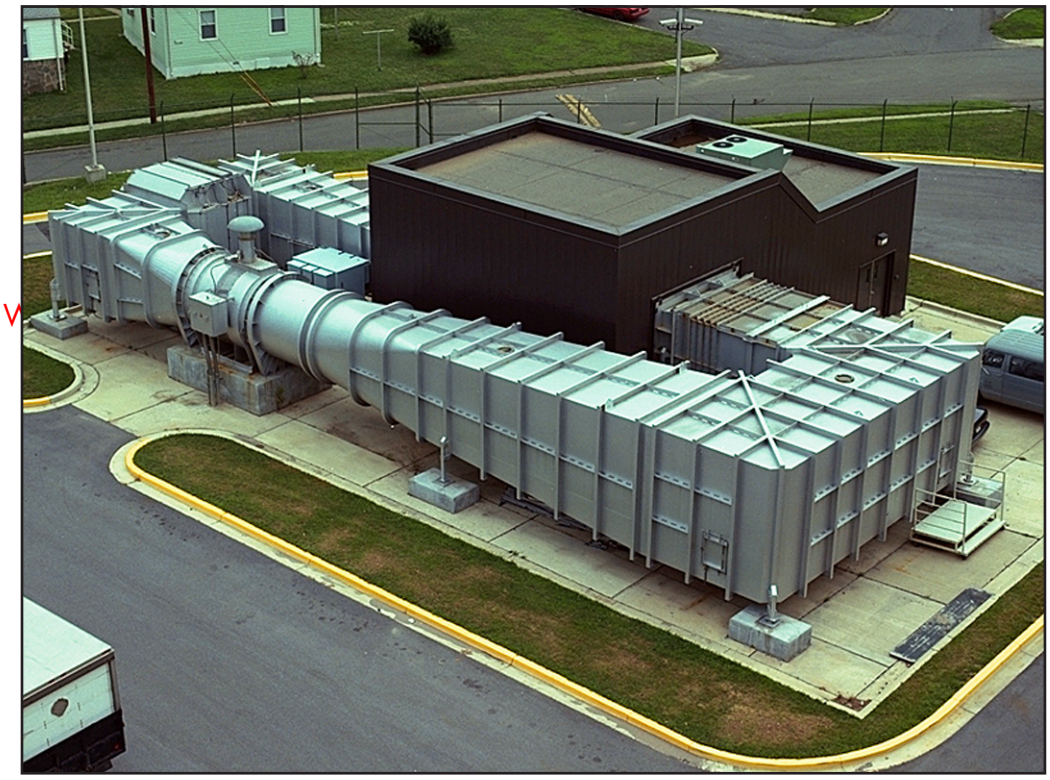
INSTRUMENTATION: The Vehicle Development Laboratory has supporting equipment and instrumentation associated with prototype flight testing such as radio control systems, miniature autopilots, video cameras, data collection systems for both onboard and RF telemetry, and a variety of sensors such as accelerometers, gyros, airspeed, and altitude transducers.

DESCRIPTION: The Vehicle Development Laboratory is involved in areas of technology development related to offboard countermeasure deployment platforms. These activities include research in new airframe materials and fabrication techniques, low-cost flight control sensors and controllers, and low Reynolds number airfoil design. Full-scale and subscale remote control and autonomous prototype vehicles are fabricated and flight tested. Also, avionics subsystems and deployment mechanisms are refined through flight testing aboard various remotely piloted test aircraft operated by the laboratory.

The Vehicle Development Laboratory has a substantial capability to fabricate airframe and mechanism test articles, light metal working, and composite structures.

CONTACT:
Code 5712 • (202) 404-7623
LOCATION:
NRL, Washington, DC

Offboard Test Platform



Offboard Test Platform

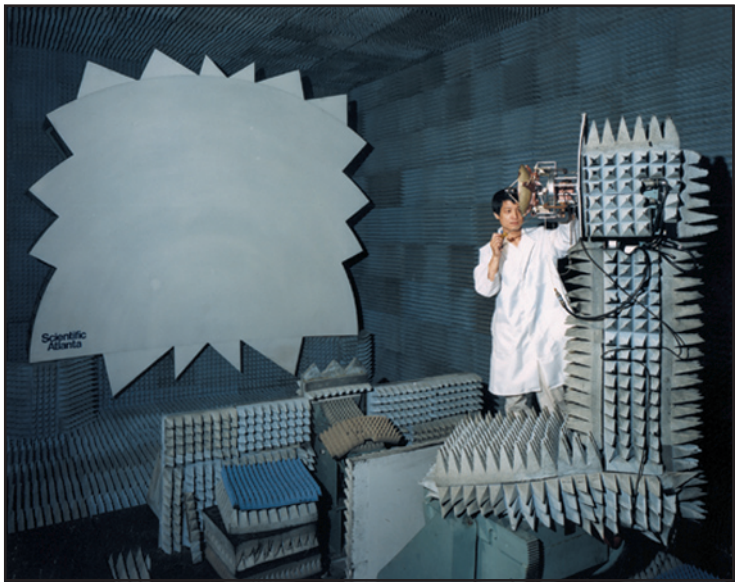
FUNCTION: Measures the aerodynamic forces and moments and studies the airflow characteristics over offboard countermeasures deployment vehicles. Supports the development and testing of propulsion systems for deployment vehicles. This facility is especially suited to the study of subsonic low Reynolds number aerodynamics because of its low turbulence intensity.

INSTRUMENTATION: The aerodynamic test section has a full three-axis, six-component strain gauge balance; a 48-port scanivalve pressure measurement system; and an automated data collection system.

DESCRIPTION: This facility is particularly focused on the development of air vehicles designed to operate at low speed, low altitude, and low Reynolds number. The wind tunnel is a continuous flow design that operates over a range of 20 to 200 kts and has two interchangeable test sections. The aerodynamic test section has a 4-ft × 4-ft cross section and a full three-axis, six-component strain gauge balance. Models are attached to the balance "sting," which can be manually or automatically controlled to sweep through ranges of angle of attack and sideslip, while force and moment data are collected. The propulsion test section is used to develop electric, internal combustion, and miniature turbojet engines. It features an open-jet test section and provides a simulation of in-flight airflow conditions.

CONTACT:
Code 5712 • (202) 404-7623
LOCATION:
NRL, Washington, DC

Compact Antenna Range Facility



Compact Antenna Range Facility

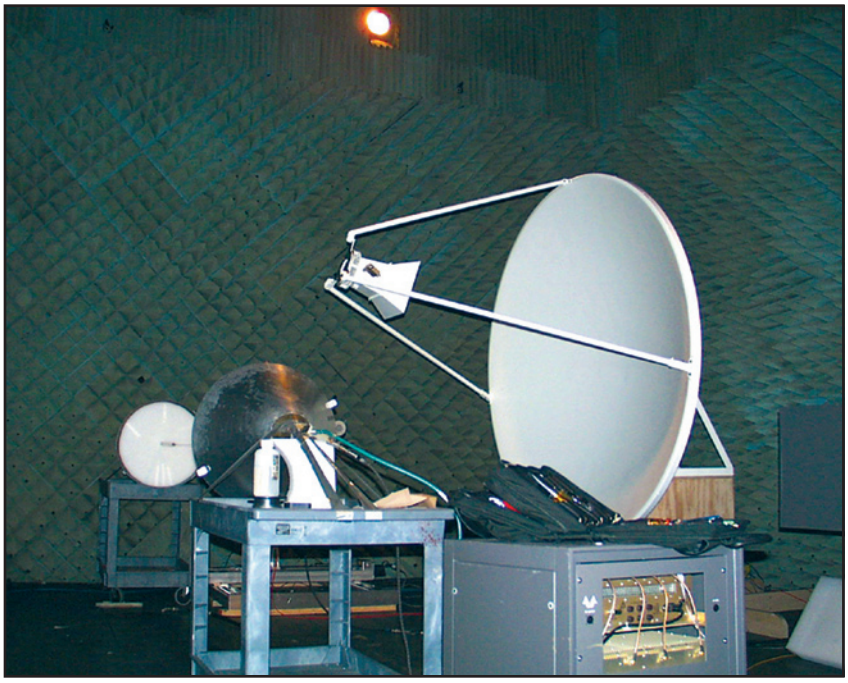
FUNCTION: Supports the measurement of phase and amplitude pattern characteristics of devices under test (DUT) over a frequency range of 2.0 to 110.0 GHz in a controlled environment. The facility also provides the capability for radar cross section (RCS) measurements over the same frequency range.

INSTRUMENTATION: The Compact Antenna Range Facility uses a complete complement of microwave laboratory instrumentation, including network analyzers, microwave receivers, spectrum analyzers, frequency counters, power meters, function generators, and microwave synthesizers. Antenna and RCS measurements are made using an Hewlett-Packard 8530 Microwave Receiver coupled with Orbit/Flam & Russell 959 Plus Antenna and RCS Measurement software. RCS measurements are visualized and analyzed using KNOWBELL software from Aeroflex, Inc. Four simultaneous channel measurements can be made to characterize an antenna or the RCS of a target from 2.0 to 110 GHz. Broadband, dual-polarized source antennas are available from 2.0 to 26.0 GHz. A high-speed source switch coupled with a 16-channel switch matrix supports 32-channel dual-polarized measurements from 2.0 to 26.0 GHz. Alternatively, 16-channel single-polarized measurements from 2.0 to 50.0 GHz are also available.

DESCRIPTION: The facility is an anechoic chamber that is designed to operate in conjunction with a Scientific Atlanta Compact Range Model 5751 with millimeter wave (MMW) reflector. The compact antenna range facility consists of a shielded anechoic chamber (18 ft high × 22 ft wide × 40 ft long) and a geometry that enables far-field radiation patterns to be taken in a small space. Illumination of the MMW reflector at one end of the chamber provides a cylindrical quiet zone (4 ft in diameter × 6 ft long) in which all the radiation patterns are measured. The quiet zone is specified to provide at least 45 dB of background noise isolation from 2.0 to 8.0 GHz and at least 50 dB from 8.0 to 94.0 GHz. The amplitude taper is specified to be no more than 0.5 dB over the quiet zone, with a corresponding specification of no more than 10 deg phase taper. Test antennas or subsystems are positioned by attaching them to an azimuth-over-elevation mount. Further degrees of freedom (DOF) are allowed with the mounting point being on a roll axis and the entire positioner on a slide axis. A second roll axis is provided for source illumination and enables the source polarization to be quickly rotated.

CONTACT:
Code 5733 • (202) 404-3014
LOCATION:
NRL, Washington, DC

Isolation Measurement Chamber Facility



12-ft antenna dish in the Isolation Measurement Chamber

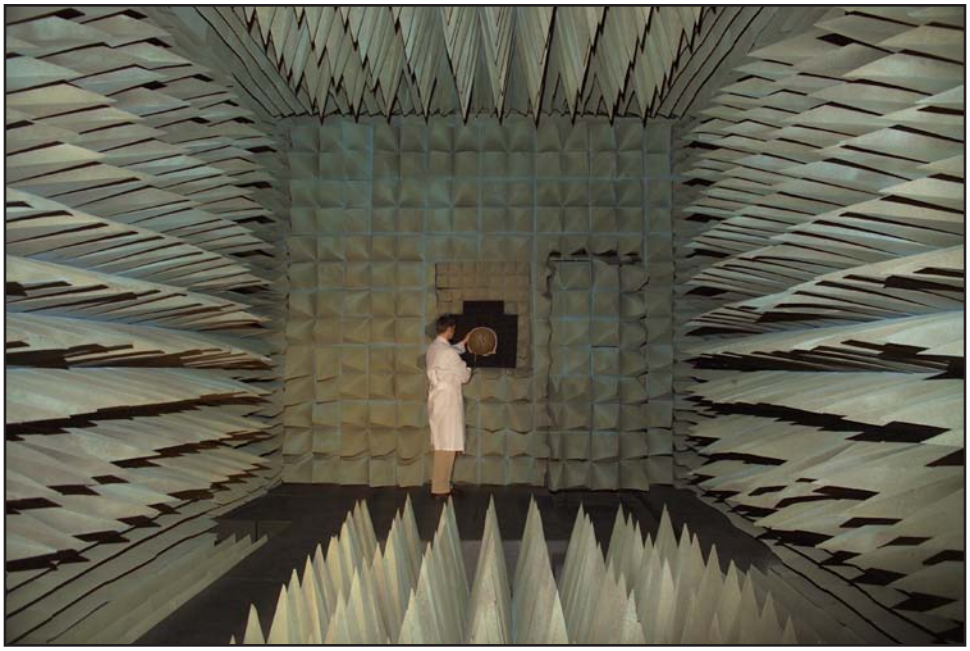
FUNCTION: Provides the capability for measuring antenna-to-antenna radiation coupling characteristics from 2.0 to 40.0 GHz. The configuration, size, and special handling equipment of the facility allow for accommodation of large antennas and devices that are under test. The facility also supports making accurate measurements of the radar cross section (RCS) of small cross-section objects.

INSTRUMENTATION: This facility has no dedicated instrumentation; users supply their own measurement equipment. Typically a Hewlett-Packard 8510C automatic network analyzer is configured to make RCS measurements of targets in the chamber. A number of different size RCS calibration spheres and antennas up to 40.0 GHz are available.

DESCRIPTION: The facility is a shielded anechoic chamber that is 24 ft wide × 30 ft long × 50 ft high. The quiet zone is located at the base of the chamber and has an extent of 12 ft wide × 18 ft long × 10 ft high. Quiet zone reflectivity measurements (i.e., dB below incident power) are >75 dB at 2.0 GHz, >85 dB at 4.0 GHz, >95 dB at 6.0 to 8.0 GHz, and >100 dB at 18.0 GHz. The chamber walls facing the control room are designed to be removed to allow installation of large targets.

CONTACT:
Code 5733 • (202) 404-3014
LOCATION:
NRL, Washington, DC

RFCM Techniques Chamber Facility



RFCM Techniques Chamber Facility

FUNCTION: Provides the capability to develop radio-frequency countermeasures (RFCM) techniques in a controlled environment from 2.0 to 40.0 GHz. The configuration of the chamber allows for direct illumination of a target system from an electronic countermeasures (ECM) system.

INSTRUMENTATION: This facility has no dedicated instrumentation; users supply both the target and ECM systems.

DESCRIPTION: The facility is a shielded anechoic chamber that is 39 ft-3-1/2 in. long x 17 ft-1 in. wide x 16 ft-1-3/8 in. high. This chamber is equipped with a moveable end wall located at the east end of the chamber and a single quiet zone located adjacent to the fixed end wall at the west end of the chamber. The quiet zone is 4 ft long x 4 ft wide x 4 ft high. The center of the quiet zone is located on the chamber boresight axis and 2 ft from the absorber tips on the fixed-end wall. Target systems are positioned by attaching them to an azimuth-over-elevation mount located in the main control room of the chamber. The system antennas would extend through an opening in the wall centered in the quiet zone of the chamber. For servicing, the mount is located on a track that allows it to be rolled back into the control room. The ECM systems are located on the other end of the chamber behind a moveable absorber wall. The ECM antennas are mounted to or placed in front of the opposite wall.

CONTACT:
Code 5733 • (202) 404-3014
LOCATION:
NRL, Washington, DC

Search Radar ECM/EA Simulator (SRES)

Search Radar ECM/EA Simulator (left) and coastal defense radar (right)

FUNCTION: This facility tests the effectiveness of electronic countermeasures/electronic attack (ECM/EA) equipment and techniques for jamming airborne search and targeting radars.

INSTRUMENTATION: Resident EA equipment includes noise sources, false target generators, and AN/ALQ-99 and AN/SLQ-32 techniques generators. Radar equipment includes a coastal defense radar system, two Plan Position Indicators (PPIs), A and B scopes, and other radar receivers. Additional data recording devices are a line printer for simulator data hard copy, photographic and S-VHS video recording of radar displays, and a microwave spectrum analyzer with camera.

DESCRIPTION: The Search Radar ECM/EA Simulator (SRES) is an electronic laboratory for developing EA techniques and for testing EA equipment. It simulates the engagement between an airborne threat search radar and a group of surface ships and aircraft that use EA as part of their defense. The simulation generates RF signals in real time that would be present in the threat radar receiver as measured from the radar echoes and EA. These signals are processed by the radar receivers and presented on radar displays for man-in-the-loop determination of EA effectiveness. An effective EA prevents the radar operator from determining the preferred target's location.

The simulator is housed in an RF-shielded room with both 60- and 400-Hz electrical power. A computer controls microwave attenuators and switches to generate the simulated radar signals. A separate Pentium personal computer controls the simulation through a graphical user interface for scenario entry. SRES uses human radar operators to achieve actual man-in-the-loop target determination and EA effectiveness.

CONTACT:
Code 5742 • (202) 767-9120
LOCATION:
NRL, Washington, DC

Low-Power Anechoic Chamber

Low-Power Anechoic Chamber for EA techniques development

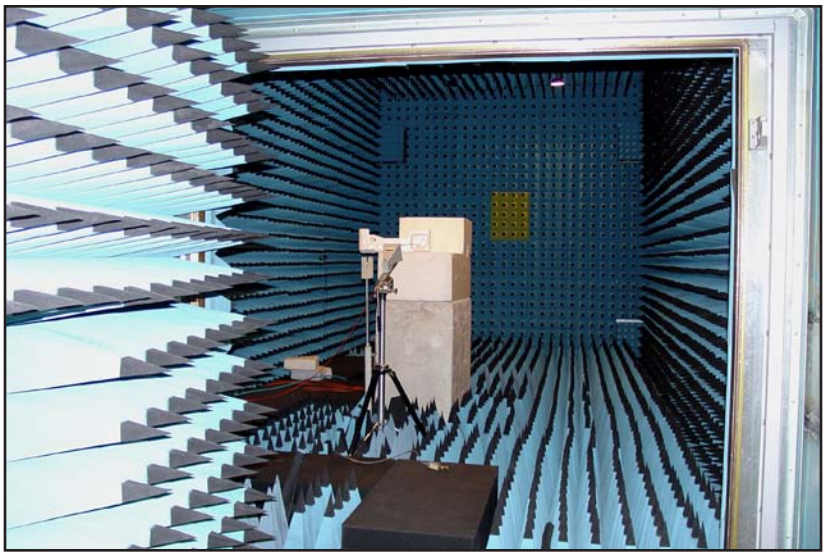
FUNCTION: Develops and evaluates the effectiveness of electronic attack (EA) techniques against antiship cruise missiles. All terminal countermeasures programmed in the active AN/SLQ-32(V) area threat libraries are developed, tested, and evaluated in this facility in open- and closed-loop test configurations. Measures of effectiveness of the EA waveforms against the missiles are obtained through closed-loop testing.

INSTRUMENTATION: EA equipment includes operational Fleet techniques generators, advanced waveform generators with capability to do cross-pole jamming, and a programmable fiber-optics delay line to replicate frequency agile return signals delayed in time and closing at antiship missile velocities. The facility instrumentation assets include an Astro-Med strip-chart recorder, an X/Y plotter, a RF spectrum analyzer, oscilloscopes, an RF power meter, and microwave sources for generating target signatures, including traveling wave tube (TWT) and solid-state, microwave, and wide-band amplifiers.

DESCRIPTION: The hardware-in-the-loop facility is instrumented to test antiship missiles operating in the I and J bands of the frequency spectrum with the capability for up to two targets, such as a ship and chaff, in the scenarios. The two targets alternatively can also be implemented to simulate two ships, each having an onboard active electronic warfare (EW) system. Missile radar seekers are mounted on a two-axis pedestal that allows closed-loop evaluation in the azimuth and elevation planes. The engagement and associated kinematics are developed using computer-controlled interactions between the pedestal and fixed and moving horns. The fixed horn is implemented using synthetic line of sight. Signals radiated in the direction of the missile radar seeker simulate targets as seen by the missile seeker, including pulse-by-pulse seeker antenna patterns, ship cross-sectional area, range attenuation, and scintillation effects. EA returns are radiated to also include the effects of seeker antenna patterns, range attenuation, and realistic jamming-to-signal ratios. The missile autopilot aerodynamics modeling is done in real time by using an Applied Dynamics Real-Time System (ADRTS) with the capability of collecting and displaying more than 50 channels of data. The antiship missile model library includes many of today's threats.

CONTACT:
Code 5743 • (202) 404-3733
LOCATION:
NRL, Washington, DC

High Power Microwave Research Facility



High Power Microwave Research Facility for
RF susceptibility measurement and analysis

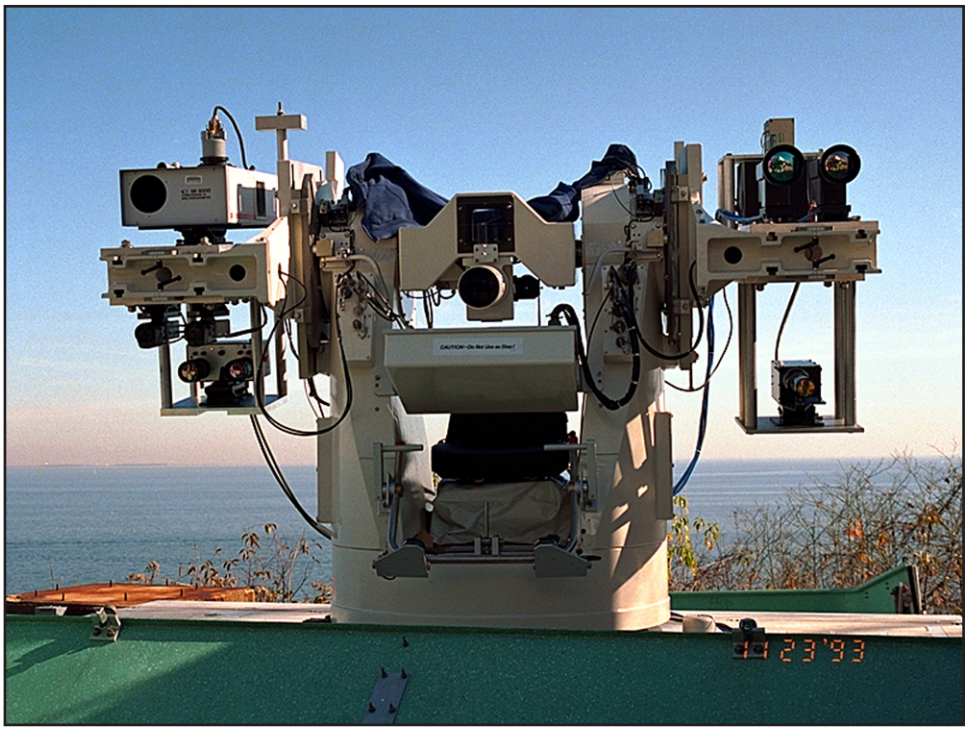
FUNCTION: The facility is used to develop and evaluate the effectiveness of high-power microwave waveforms for the disruption of electronic systems. Included in the facility are an anechoic chamber, associated RF sources and instruments, and a 32-processor Beowulf cluster. High-power RF frequencies between 0.6 and 100 GHz may be used inside the chamber. Simulation and analysis may be carried out with the Beowulf cluster.

INSTRUMENTATION: The facility contains sources, RF measurement equipment, and data acquisition instrumentation. Available RF sources include high-power travelling wave tubes (TWTs) and magnetrons to provide both continuous and short-pulse high-power RF. Horn antennas covering the frequency range of interest are also available. Survey meters are available for measuring RF inside and outside the chamber along with a variety of power meters and associated probes. High-speed scopes and spectrum analyzers are also available for the measurement and analysis of waveforms. A network analyzer may also be used to carry out circuit measurements. Data acquisition may be carried out with either hard-line coax connections or fiber-optic systems.

DESCRIPTION: The facility is used to test the response of electronic systems to high-power RF waveforms. Primary interest is in the disruption of the function of a system using out-of-band waveforms, i.e., waveforms with frequencies that are not normal operating frequencies of the device. One of the objectives is to find waveforms that may disrupt a large number of systems with power levels that are as low as possible. Positioners are available to displace the system or the radiating antenna to obtain angular information. The performance of the system is monitored to determine the portion of the system that was affected by the RF waveform. More invasive instrumentation may also be used to determine point of entry. The facility is also used to develop techniques that will harden systems to RF attack. Once RF susceptibilities and RF entry points are determined, hardening techniques may be evaluated to determine the level of protection provided.

CONTACT:
Code 5745 • (202) 767-5746
LOCATION:
NRL, Washington, DC

Electro-Optics (E/O) Mobile Laboratory



Electro-Optics Mobile Laboratory

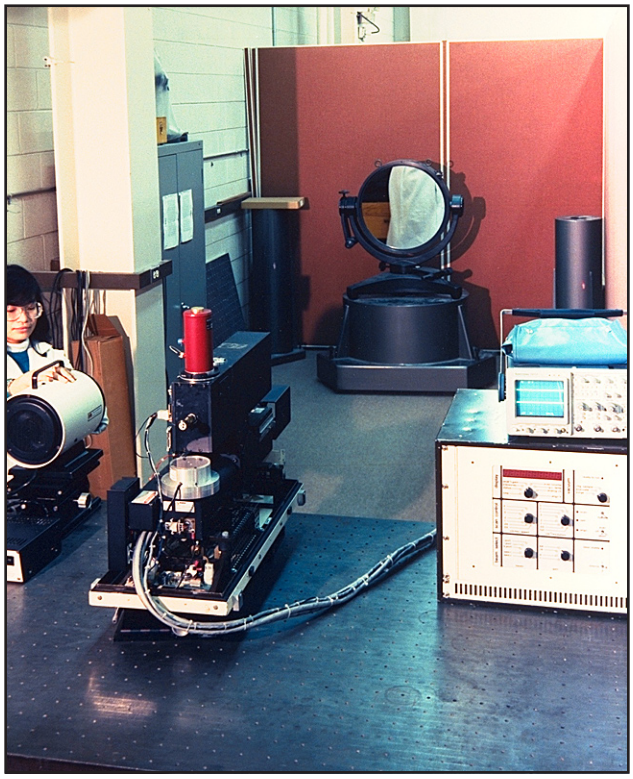
FUNCTION: Provides quantifiable IR spatial and spectral radiometric measurements of various types of targets. Typical targets are ships, aircraft, or IR decoys.

INSTRUMENTATION: Electro-Optics (E/O) Mobile Laboratory test equipment includes weather, ranging, video, and electro-optical instruments. Radiometric and imaging instruments are calibrated and characterized before each test. Equipment currently in use includes: a Bomem MR254 high-speed Fourier transform infrared (FTIR) interferometer spectrometer (1.5 to 14 μm), Indigo Phoenix MW (3 to 5 μm) and LW (8 to 9 μm) imagers, and an Indigo Merlin imager (3 to 5 μm). Calibrations are verified in the field with IR blackbody sources to assure accuracy and consistency.

DESCRIPTION: The E/O Mobile Laboratory is a specially modified, fully instrumented vehicle, and a trailer-configured precision tracking mount. This facility provides the work space, storage, and power for instrumentation racks and their operators. Front-end optics and electronics are boresighted on the Kineto tracking mount to provide a stable platform. The mount provides motions of 640-deg azimuth and 90-deg elevation at up to 60 deg/s. Full velocity can be reached within 1 s from a standing position with a full load of 300 lb on each arm along with the operator. This mobile laboratory is outfitted for visual and IR imagery, which can be used for tracking or spatial measurements. High-precision IR radiometers and interferometers provide calibrated measurements in both 3 to 5 μm and 8 to 12 μm bands. A full data acquisition system permits archiving and prompt data reduction.

CONTACT:
Code 5750 • (202) 767-3337
LOCATION:
NRL, Washington, DC

Infrared/Electro-Optical Calibration and Characterization Laboratory



Infrared/Electro-Optical Calibration and Characterization Laboratory

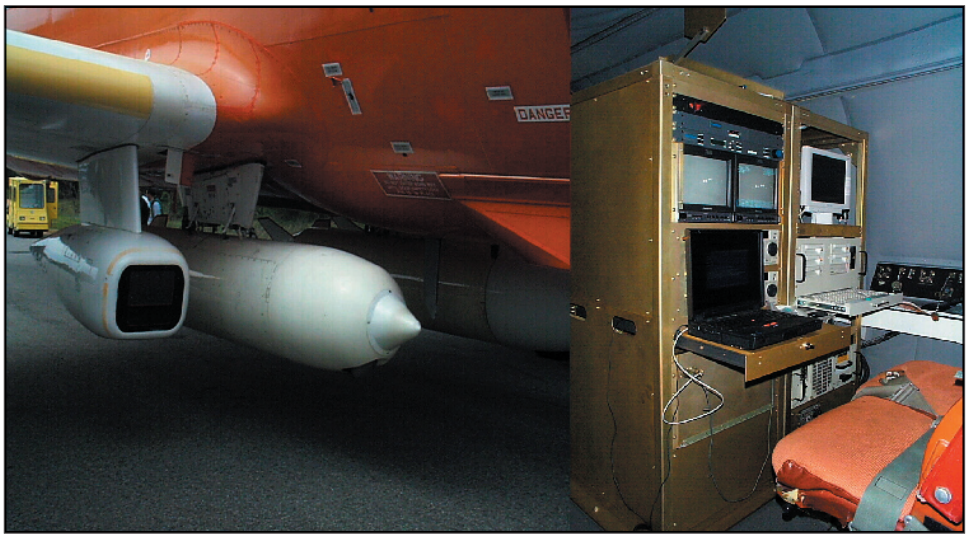
FUNCTION: Enables the optical characterization of IR materials and precise calibration of IR radiometric and spectroscopic instrumentation.

INSTRUMENTATION: Included are state-of-the-art instruments and devices. Calibration is carried out with precision IR calibration sources and a 24-in. diameter, 200-in. focal length, off-axis collimator. IR paints and materials are characterized by several instruments including a Bomem DA2 Fourier transform infrared (FTIR) spectrometer with integrating spheres for visual and IR bands giving values for total and diffuse reflectance. These calibrations can be carried out at several ambient temperatures using a Tenny environmentally controlled chamber.

DESCRIPTION: The Infrared/Electro-Optical Calibration and Characterization Laboratory is an essential element of NRL's IR signature measurement and signature control programs. Naval Sea Systems Command-supported ship signature measurement and ship decoy development programs rely on this laboratory for accurate calibration of instruments such as interferometer spectrometers, circular variable filter radiometers, and IR imaging radiometers. For IR signature control programs, the facility provides the capability of characterizing the surface emissive and reflective properties of IR paints and materials. Measurements are made on transmittance, specular reflectance, diffuse reflectance, and bidirectional reflectance.

CONTACT:
Code 5750 • (202) 767-3337
LOCATION:
NRL, Washington, DC

Infrared (IR) Missile Simulator and Development Laboratory



Infrared Missile Simulator and Development Laboratory

FUNCTION: Determines the effectiveness of ship-based IR decoys and IR laser countermeasure (CM) systems against IR-guided antiship missiles (ASM). Develops performance bounds of IR ASMs to detect and engage both conventional and signature-reduced U.S. surface platforms and to evaluate the performance of various infrared countermeasure (IRCM) techniques.

INSTRUMENTATION: An extensive array of optical and electronic analysis equipment supports the development, test, and operation of the EO/IR simulators. Test and analysis of much of the electronics are accomplished through custom interfaces coupled to portable computer-based data acquisition subsystems. Software development facilities are a major feature of the simulators, which use both high-level and assembly-level code for real-time operations. A high-performance emulation environment makes development of this complex code possible.

DESCRIPTION: The IR Missile Simulator and Development Laboratory includes IR seeker simulators and a fully equipped laboratory for sensor evaluation, processor design and development, flight hardware assembly, algorithm design, and data analysis. The aircraft-mounted systems use fiber-optic communications between the wing pod and the instrumentation/display inside the aircraft. This provides low noise on all data channels. The simulator systems contain an integrated data system for analysis of extensive field trials and allow ready visualization of both the actual tests and post-test data reduction. One simulator is a reprogrammable system permitting evaluation of multiple threats. Detector configurations and algorithms are changed to approximate threats. Another flyable simulator supports research on imaging IR seekers. The large system gimbal accommodates newly developed imaging IR cameras. By using a flexible software architecture, a complete missile seeker system with exceptional flexibility to incorporate new algorithms and infrared counter-countermeasure (IRCCM) approaches is obtained. Digital data collection allows post test analysis, system development, and simulation.

CONTACT:
Code 5750 • (202) 767-3337
LOCATION:
NRL, Washington, DC

Secure Supercomputing Facility (SSF)

Secure Supercomputing Facility

FUNCTION: Provides NRL, the Navy, and DoD with a high-speed, large-memory computation facility for classified projects. Throughput is comparable to over 500 Cray XMPs with large solid-state disks and represents over 100 teraflops of processing power.

INSTRUMENTATION: Secure Supercomputing Facility (SSF) visitors are accommodated in spaces featuring high-performance workstations, X terminals and PCs, and a complement of printers. A rich set of productivity tools is available including: X windows and Motif graphical user interfaces, a full set of UNIX network connectivity tools, industry standard editors, UNIX tools and debuggers, high-performance Math libraries, parallel and distributed programming tools, data visualization, and multimedia tools.

DESCRIPTION: The SSF centerpiece is a 128-processor SGI Origin 3000. Each processor can achieve 500 Mflops and has 128 GB of physical memory and 128 GB of virtual memory. Local disk storage (>360 GB) uses removable Winchester disk cassettes. The facility's computational capability is supplemented by two additional computers: (1) an SGI Origin 3000 system with 48 processors (500 Mflops each) and 48 GB of physical memory, and (2) an SGI Origin 2000 system with 32 processors (350 Mflops each) and 16 GB of physical memory. The SSF includes a fully automated, extensible network file server with a storage of 2 Terabytes. Access to the SSF is restricted to workspaces within the controlled perimeter of the Tactical Electronic Warfare Division (TEWD) building complex. For more highly controlled projects, normal mode and TEWNET access ceases and the SSF and vault enclosure become dedicated to the particular project. Each project uses its own exclusive complement of removable disk cassettes as well as system and application software.

CONTACT:
Code 5750 • (202) 767-3337
LOCATION:
NRL, Washington, DC

CBD/Tilghman Island IR Field Evaluation Facility

Tower on Tilghman Island:
16-km over-water path to CBD

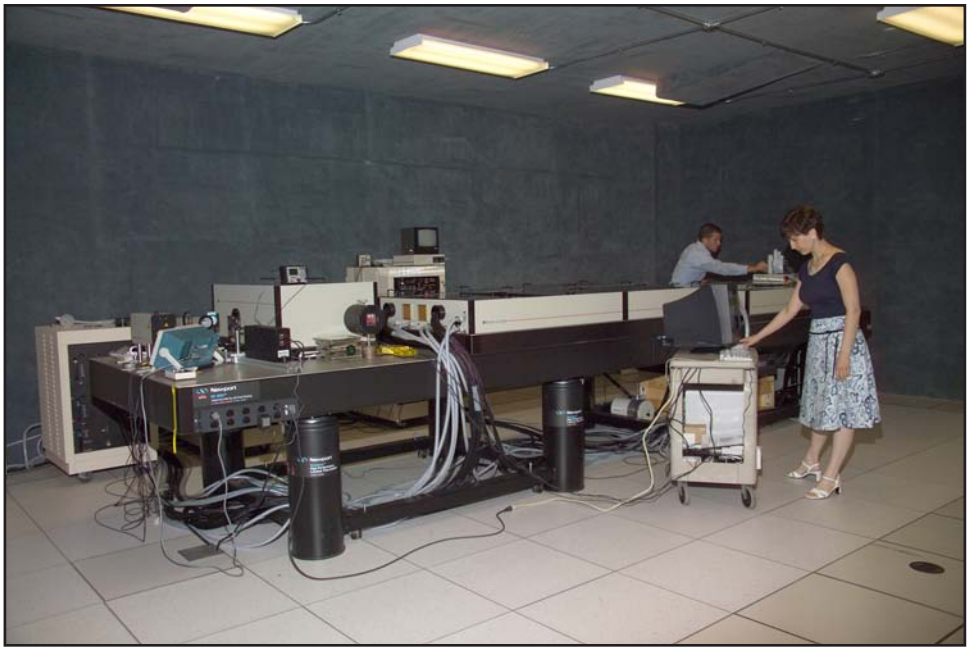
FUNCTION: This is a research and development facility for electro-optics/infrared (EO/IR) threat simulators including antiship-capable missile seekers. The facility also enables field evaluations of EO/IR countermeasures (decoys and active jamming) in an over-water environment with a focus on the protection of Navy ships.

INSTRUMENTATION: The Chesapeake Bay Detachment (CBD) site overlooks the bay and includes instrumentation power and environmental controls in a large space for multiple antiship-capable seeker simulators and reference instrumentation. This site has an environmentally controlled space with optical bench. The Tilghman Island site features a 100-ft tower, affording a 16-km over-water path to the CBD site. The tower includes instrumentation power and environmental controls for the seeker simulators. Also support ships are available as reference targets and to deploy decoys.

DESCRIPTION: Located on the western side of the Chesapeake Bay is Building 5, which houses EO/IR sensors, sources, and measurement instrumentation. This building is set on a 30-meter-high cliff overlooking the bay. Sixteen kilometers across the bay is the Tilghman Island Facility with a tower that contains instrumentation and threat simulators. These facilities enable the research that leads to the development of techniques and systems to defeat antiship-capable missile threats. The reference instrumentation quantifies the countermeasure performance and records the environmental conditions. Countermeasures may be deployed from either shore-based locations or from one of the support ships that are attached to the Chesapeake Bay Facility.

CONTACT:
Code 5750 • (202) 767-3337
LOCATION:
Chesapeake Bay Detachment and Tilghman Island, MD

Ultra-Short Pulse Laser Effects Research and Analysis Laboratory



High-Power, Ultra-Short Pulse Laser

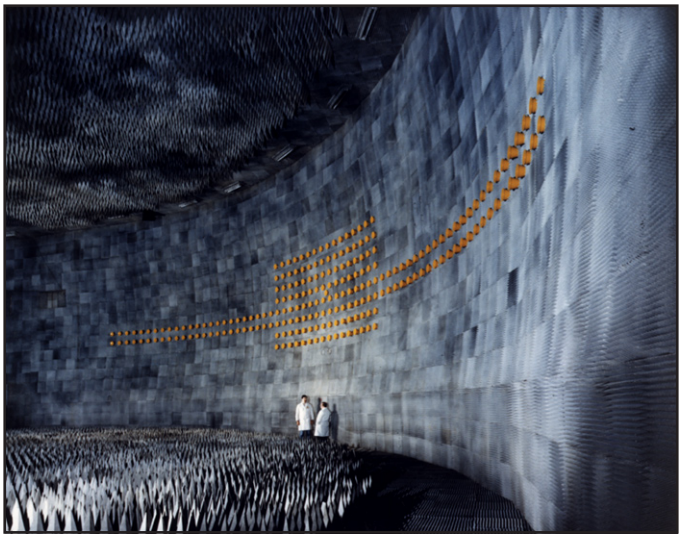
FUNCTION: Enables research into advanced laser countermeasure techniques.

INSTRUMENTATION: The key component in the facility is an ultra-short pulse laser with very high peak power. The operating environment has a tightly controlled temperature and low-humidity system. A foundation separate from the rest of the building isolates the laser from the normal building vibrations. Measurement instrumentation monitors the laser's performance as well as the systems that are excited by the laser.

DESCRIPTION: This laser facility has a capability to produce very high peak power levels of 27.5 TW while maintaining a low average power of 11 W. This combination keeps the laser physically compact, permitting potential tactical applications. To determine the critical aspects of the laser and test system interaction, the laser facility's temperature is tightly controlled and the humidity is held to a low level. Vibration isolation is also a key feature of the facility.

CONTACT:
Code 5750 • (202) 767-3337
LOCATION:
NRL, Washington, DC

Central Target Simulator (CTS) Facility



Central Target Simulator Facility

FUNCTION: A high-performance, hardware-in-the-loop simulator for real-time closed-loop testing and evaluation of electronic warfare (EW) systems and techniques to counter the antiship missile threat to the U.S. Navy in the 8.0 to 18.0 GHz frequency range. Tests use actual missile hardware and closure rates, enabling test results to be reported in the form of hit/miss distances. In addition, open-loop characterization tests evaluate the capabilities of threat systems and contribute data to the threat simulator validation process.

INSTRUMENTATION: The facility uses general laboratory instrumentation and recording equipment to display and capture information relative to the tests being conducted. The simulation computer stores pertinent information from the scenario, along with 16 analog channels and 32 digital bits captured from the missile radar. A closed circuit television (CCTV) system allows remote displays to be viewed in the control room and throughout the facility, with recording via two VCRs. Communication is provided by a dedicated audio intercom.

DESCRIPTION: The Central Target Simulator (CTS) Facility is built around a 114-ft × 127-ft × 38-ft high shielded anechoic chamber. A spherical array of 225 dual-polarized antennas is used to simulate the RF environment that the missile encounters in an engagement. Two feed networks distribute time and space coincident signals. The RF generation subsystem is synchronized to the missile radar in time and frequency. State-of-the-art modulation equipment replicates the characteristics of ship and decoy echoes, correctly triggering target discriminants. External inputs allow jamming signals or waveforms to be included. Missile hardware is mounted 75 ft from the array on a three-axis flight-motion simulator. The loop between the missile and the facility is closed through a dual Xeon computer. This computer is programmed with a 6-degree of freedom (DOF) aerodynamics/autopilot model that interacts with the guidance hardware in response to the RF stimuli. Simulations run in real time at update rates of up to 200 Hz. A battery of open-loop characterization tests is used to evaluate the performance of the missile radar subsystems, identifying design features, vulnerabilities, or limitations for potential exploitation by EW tactics and techniques.

CONTACT:
Code 5760 • (202) 767-2208
LOCATION:
NRL, Washington, DC

Flying Electronic Warfare Laboratory

Flying Electronic Warfare Laboratory

FUNCTION: Provides NP-3D aircraft host platforms for Effectiveness of Navy Electronic Warfare Systems (ENEWS) Program antiship missile (ASM) seeker simulators used for electronic warfare (EW) effectiveness assessment in an at-sea environment. This capability provides the Navy's research, development, test, and evaluation (RDT&E) and operational communities with unique assets and realistic methods for evaluating surface Navy EW systems.

INSTRUMENTATION: Two NP-3D aircraft are configured to carry the simulators. These simulators represent a large cross section of the threat missile systems available worldwide and are derived from other programs or are hardware systems modified to represent various threat seekers. All of the simulators are unique, one-of-a-kind systems, with the associated instrumentation tailored to the individual simulator. Global Positioning System (GPS) and data link systems allow the collection of aircraft and ship's position information for ground truth determination.

DESCRIPTION: The Flying Electronic Warfare Laboratory provides ASM threat representation through the adaptation of a host of missile seeker simulators. These simulators use a combination of hardware/software to model the external parameters/internal functions of various threat systems. Operational testing against ship's EW assets is enhanced through the unique ability to provide real-time feedback of the effectiveness of electronic attack (EA) responses to the threat seeker's stimuli. Fifteen different simulators representing various ASM threat types are available as part of the ENEWS Program. Up to eight simulators can be operated simultaneously to exercise the on/offboard EW assets being tested. Internally mounted equipment racks contain seeker control panels, data displays, data acquisition systems, and communications systems that are organic to each simulator. Special features include the ability to monitor/record simulator status, receiver/processor functions and select decision logic. The Laboratory supports RDT&E and operational activities on a worldwide basis, providing EW testing support to U.S. and NATO programs and those of individual countries.

CONTACT:
Code 5760 • (202) 767-0242
LOCATION:
Naval Air Warfare Center, Patuxent River, MD

MATERIALS SCIENCE AND COMPONENT TECHNOLOGY DIRECTORATE

Code 6030 – Laboratory for Structure of Matter

Code 6100 – Chemistry Division

Code 6300 – Materials Science and Technology Division

Code 6400 – Laboratory for Computational Physics and Fluid Dynamics

Code 6700 – Plasma Physics Division

Code 6800 – Electronics Science and Technology Division

Code 6900 – Center for Biomolecular Science and Engineering

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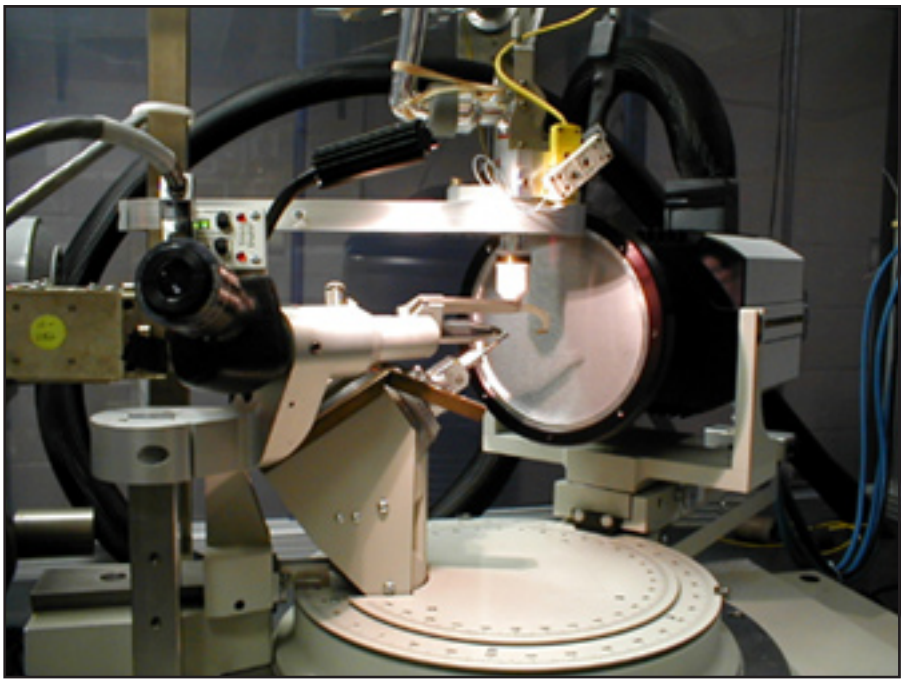
Laboratory for Structure of Matter

- Automatic X-ray Diffractometers
- Atomic Force Microscope

Automatic X-ray Diffractometers



Bruker 6000 CCD X-ray detector mounted on a platform goniometer

FUNCTION: Carries out atomic resolution, single-crystal, X-ray diffraction analyses. Capabilities exist to examine a wide range of materials from small inorganic molecules to macromolecular biological compounds.

INSTRUMENTATION:

- A Bruker 6000 charge-coupled device (CCD) area detector mounted on a three-circle goniometer. This equipment is coupled to a rotating anode Cu-Kα X-ray source using high brilliance Gobel mirror X-ray optics
- A Bruker 1000 CCD area detector mounted on a four-circle goniometer using a sealed tube Mo-Kα X-ray source and an incident beam graphite monochromator
- A Bruker P4 serial detector on a four-circle goniometer using a sealed tube Cu-Kα X-ray source and an incident beam graphite monochromator.

DESCRIPTION: The site includes laboratories for sample preparation and purification. Laboratory facilities are also provided for crystal growth. Three automated X-ray diffractometers are available for data acquisition, all of which may be operated over a range of sample temperatures (22° to –180 °C). High-speed computational facilities are in place for structure solution and analyses.

CONTACT:
Code 6030 • (202) 767-0656
LOCATION:
NRL, Washington, DC

Atomic Force Microscope

Main components of the atomic force microscope

FUNCTION: The atomic force microscope (AFM) is a surface-scanning instrument that detects surface topography with a lateral resolution of 0.5 to 1.0 nm and a vertical resolution of 0.1 to 0.2 nm.

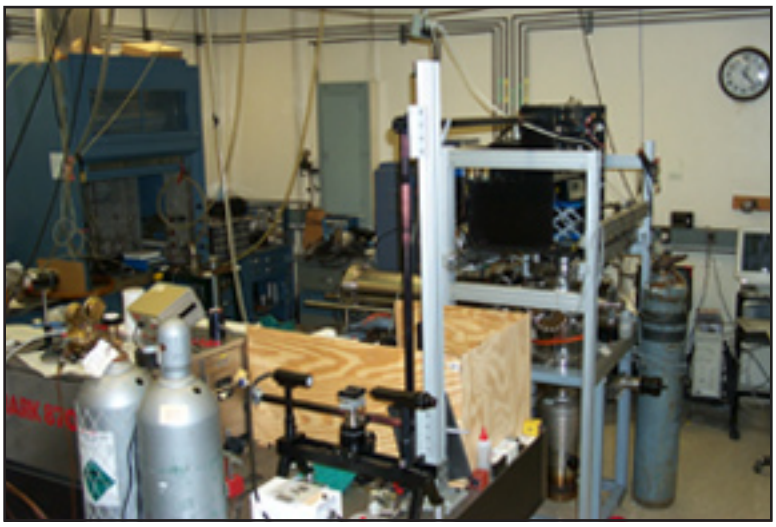
DESCRIPTION: Our AFM is currently dedicated to the study of mechanisms involved in the growth of single crystals of biologically active macromolecules suitable for X-ray diffraction studies. This instrument scans a sharp stylus, located at the end of a flexible cantilever, over the crystal surface. Surface images are obtained of dynamically growing crystals that have been placed in a fluid cell. The concentrations of the various species, in solution and temperature, are varied to directly observe the effects on the crystal growth process. The goal is to reproducibly grow crystals with few defects.

CONTACT:
Code 6030 • (202) 767-3267
LOCATION:
NRL, Washington, DC

Chemistry Division

- Chemical Analysis Facility
- Magnetic Resonance Facility
- Corrosion Engineering and Coatings Characterization Facilities
- Marine Corrosion Facility
- Chemical Vapor and Plasma Deposition Facility
- Nanometer Characterization/Manipulation Facility
- Synchrotron Radiation Facility
- Ex-USS Shadwell Advanced Fire Research Ship
- Fire Research Enclosure
- Large-Scale Damage Control Facility

Chemical Analysis Facility



Chemical Analysis Facility

FUNCTION: Uses state-of-the-art instrumentation for qualitative and quantitative analysis of organic and inorganic compounds, and biomolecules from gas, liquid, and solid samples. Principal functions of the facility include analyzing samples of environmental importance, ranging from the atmospheres of submarines to polycyclic aromatic hydrocarbons in harbor sediments, and characterizing synthetic products and materials (such as polymers).

INSTRUMENTATION: The facility contains gas chromatographs with flame ionization, thermal conductivity, and electron capture detectors; liquid chromatographs with ultraviolet (UV)-visible, fluorescence, and mass spectrometer detectors; capillary electrophoresis instruments with UV-visible and conductivity detectors; a thermal desorption/gas chromatograph/mass spectrometer; a gas chromatograph/ion trap tandem mass spectrometer; a membrane introduction/ion trap tandem mass spectrometer; electrospray triple quadrupole and electrospray ion trap tandem mass spectrometers; a matrix-assisted laser desorption time-of-flight mass spectrometer; an imaging two-step laser/desorption laser ionization time-of-flight mass spectrometer; graphite furnace atomic absorption and inductively coupled plasma (ICP) emission spectrometers; and infrared, Ramen UV-visible, and nuclear magnetic resonance (NMR) spectrometers.

DESCRIPTION: The facility includes instrumentation for characterizing many types of samples using a variety of analytical techniques. Environmental samples (air, water, and sediment) are prepared by techniques such as solid-phase micro-extraction, solid-phase extraction, membrane introduction, liquid extraction, and thermal desorption. Quantitative and qualitative analytical information is provided by gas chromatography, gas chromatography/mass spectrometry, liquid chromatography, liquid chromatography/mass spectrometry, capillary electrophoresis, infrared spectrometry, UV-visible spectrophotometry, atomic absorption spectrometry, and atomic emission spectrometry. More detailed information about molecular structures can be obtained by NMR spectrometry, isotope ratio mass spectrometry, matrix-assisted laser desorption mass spectrometry, and electrospray tandem mass spectrometry. The capability to characterize the spatial location of molecules on surfaces, while maintaining molecular weight information, has been added in a new imaging laser desorption/laser ionization mass spectrometer. Synthetic samples are handled in a similar fashion using many of the same techniques.

CONTACT:
Code 6110 • (202) 404-6392
LOCATION:
NRL, Washington, DC

Magnetic Resonance Facility

Magnetic Resonance Facility

FUNCTION: Addresses basic and applied research problems in materials chemistry. Critical Navy problems in materials performance and reliability are stressed, utilizing innovative techniques and approaches, principally in magnetic resonance.

INSTRUMENTATION: The facility operates advanced Bruker, Fourier transform (FT) NMR spectrometers at 11.7 and 7.0 Tesla for solids and liquids, with provisions for variable temperature multi-nuclear studies, magic-angle spinning, double and triple resonance, high power decoupling, gradient-enhanced spectroscopy, and liquids micro-imaging. Specialized spectrometers for NMR of solid samples at pressures to 1 GPa, or temperatures to 4.2 K, and for nuclear quadrupole resonance are also available.

DESCRIPTION: Advanced high-resolution solid-state nuclear magnetic resonance (NMR) spectroscopy techniques can be used to observe nuclei across much of the Periodic Table and provide detailed structural and dynamical information. NMR imaging techniques can also be applied to non-destructive evaluation of materials.

CONTACT:
Code 6122 • (202) 767-2337
LOCATION:
NRL, Washington, DC

Corrosion Engineering and Coatings Characterization Facilities

Corrosion Engineering and Coatings Characterization Facilities

FUNCTION: Performs materials corrosion engineering and prevention studies, cathodic protection design, marine coatings characterization, electrochemical systems, seawater sensor systems, and materials failure analysis related to marine environments. Additionally, laboratories support efforts at the NRL Center for Corrosion Science and Engineering located in Key West, Florida.

EQUIPMENT: Electrochemical testing equipment for ac and dc measurements; Kelvin probe; Fourier transform infrared spectroscopy; gas chromatography/mass spectroscopy; Zeta potential measurement system; Participating Research Team (PRT) member on beamline X11 at the National Synchrotron Light Source (NSLS); fuel cell test station; X-ray photoelectron spectroscopy; and X-ray fluorescence.

DESCRIPTION: Specialized analytical laboratories determine the mechanisms of materials degradation and develop coatings technology for Naval systems. Seawater effects on materials are studied to understand fundamental physical properties of the electrochemical reactions, mechanisms of materials degradations, and the methodology for materials preservation and protection. The facilities include basic electrochemical test laboratories, surface chemical analysis, organic coatings properties measurement, mechanical failure analysis, stress-corrosion cracking/hydrogen effects instrumentation, analytical analysis, and corrosion properties measurement. Marine coatings laboratories enable the analysis of barrier coating properties, surface preparation scenarios, application, and performance testing. Electrochemical facilities enable the theoretical understanding of interfacial processes and surface chemistry and use the information gained to guide materials development, improve material performance, and reduce maintenance costs.

CONTACT:
Code 6130 • (202) 767-0833
LOCATION:
NRL, Washington, DC

Marine Corrosion Facility

Marine Corrosion Facility

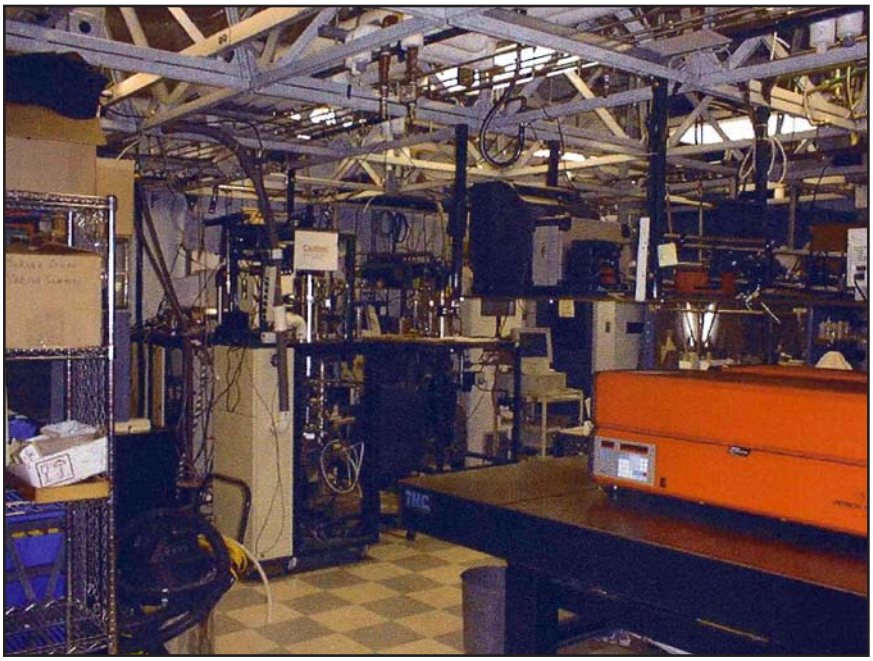
FUNCTION: Conducts research, development, test and evaluation (RDT&E) in direct support of current and 21st Century Fleet requirements concerning seawater materials performance, corrosion behavior, and marine coatings technology.

CAPABILITIES: Cathodic Protection/Signature Analysis Physical Scale Modeling Facility; coatings testing and application facilities; controlled Atmosphere Coatings Application Chamber; weatherometer and Environmental Effects Laboratory; Heat Exchanger Test Facility; Corrosion, Metallography, and Electrochemistry Laboratory; seawater flow loop and low-velocity exposure troughs; 5- to 30-kt seawater flow channel; 55,000 and 110,000 gallon modeling tanks; 0 to 1000 psi pressurized seawater flow loop; 800-ft instrumented sacrificial anode test pier; ultraviolet (UV) and salt spray environmental test chambers; atmospheric exposure test racks; cantilever beam stress-corrosion cracking (SCC)/hydrogen effects testing; and two remotely operated vehicles.

DESCRIPTION: The Marine Corrosion Facility is located on the Naval Air Station, Trumbo Point Annex, adjacent to Key West, FL. The laboratory has an unparalleled database for natural seawater exposure testing and marine-related materials evaluation. It receives a plentiful, unpolluted supply of natural undisturbed Gulf of Mexico seawater throughout the year. The tropical climate is ideally suited for marine exposure testing and provides a minimal climatic variation, with a stable biomass throughout the year. The laboratory has more than 1000 ft of waterfront access, natural "blue" ocean-quality seawater access, a 2500-ft^2 atmospheric test site, and more than 14,000 ft^2 of laboratory facilities.

CONTACT:
Code 6136 • (305) 293-4214
LOCATION:
Naval Air Station • NRL, Key West, FL

Chemical Vapor and Plasma Deposition Facility



A unique facility for the study of chemical vapor deposition and plasma processing with a diverse array of diagnostic tools including laser, Fourier transform infrared, and mass spectroscopies.

FUNCTION: Facility to study and fabricate materials such as diamond by chemical vapor deposition and plasma processing, using in situ diagnostics (laser spectroscopies, Fourier transform infrared (FTIR), optical emission and mass spectroscopy), laser machining, and plasma deposition reactors.

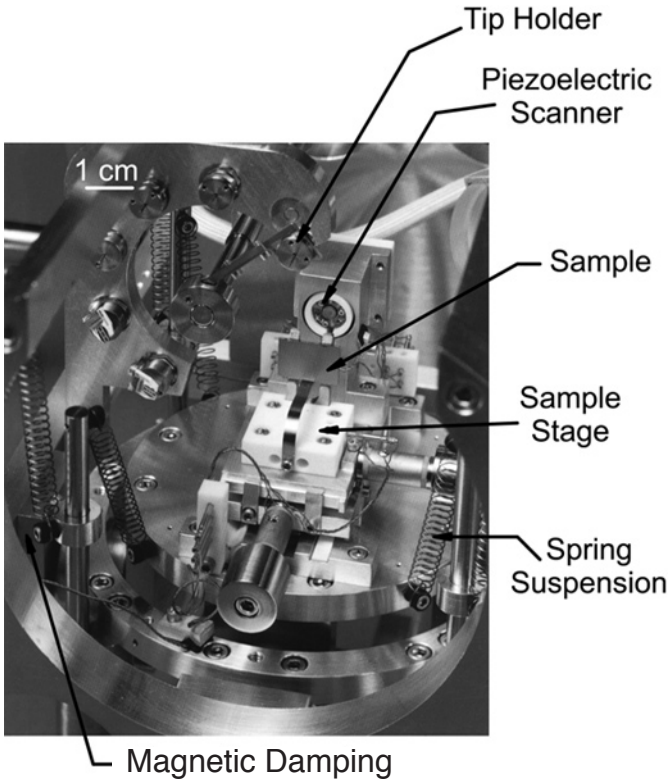
DESCRIPTION: Fundamental and applied research is conducted in a dedicated laboratory space with single-pass air flow, toxic gas alarm system, and gas scrubbers on exhaust air. The research is directed toward the growth and surface chemistry of advanced materials, the spectroscopy of species at or near interfaces, and the molecular/structural characterization and modification of surfaces and solid-gas interfaces. To this end, techniques involving chemical vapor deposition (CVD), high temperature environments, photon-assisted processes, and plasma processing and plasma deposition/etching are applied. Such modified surfaces/interfaces impact a broad array of DoD-related problems including plasma modification, processing electronic devices, protective coatings, corrosion, and synthetic metastable materials.

INSTRUMENTATION: Advanced Materials Facility - CVD, Plasma Processing, and Laser Diagnostics Lab featuring: four microwave plasma enhanced deposition facilities (ASTeX HPMM and electron cyclotron resonance (ECR) plasma deposition chambers); novel inductively coupled plasma research tools; FTIR spectrometers; a triple monochromator, microscope, and optical multichannel channel analyzer for raman/emission spectroscopy of surface species; a Lambda Physik 2101 Excimer laser, a Quantel Nd/YAG laser, a Lambda Physik LPD 3002E dye laser, and an auto-tracking frequency doubling system; quadrupole mass spectrometer in situ sampling system (Hiden) with automated data acquisition; a CW q-switched YAG laser machining facility for cutting diamond films; a novel RF inductively coupled pulsed plasma source for CVD, etching, and material modification.

CONTACT:
Code 6174 • (202) 767-3321
LOCATION:
NRL, Washington, DC

Nanometer Characterization/Manipulation Facility

Close up view of a scanning tunneling microscope (STM) used for the study of semiconductor surfaces and interfaces



FUNCTION: Characterizes the nanometer scale of biological, chemical, physical, electronic, and mechanical properties of surfaces and thin films using scanning probe microscopies/spectroscopies, and a variety of complementary surface analysis techniques. The limits of materials miniaturization are explored by using the new microscopes to fabricate and manipulate surface structures of nanometer size. This technology is used to investigate new chemical, biological, and magnetic sensors, electronic devices, and nanoscale materials.

INSTRUMENTATION: NRL-built ultrahigh vacuum (UHV) scanning tunneling microscope/spectroscope (STM/S) with facilities for low-energy electron diffraction (LEED) and Auger electron spectroscopy (AES); Omicron UHV variable temperature STM/atomic force microscope (AFM) integrated with a second UHV system, housing a multitip STM with a scanning electron microscope (5 nm resolution) and scanning Auger microprobe; Park Scientific Instruments AutoProbe UHV STM/AFM integrated with the NRL Molecular Beam Epitaxy (MBE) Epicenter for characterizing semiconductor surfaces following MBE, including cross-sectional STM; Nanoscope IIIa multimode AFM (lateral force, magnetic force, and tapping modes) equipped with breakout box and force-volume mapping system; TM Microscopes Autoprobe CP AFM used for dip pen nanolithography; Digital Instruments Bioscope AFM integrated with a Zeiss Axiovert 100 inverted optical microscope with fluorescence, micromanipulation, and microinjection capabilities; and Nanoscope IIIa and Multimode AFM, NRL-built lateral-force microscope, and Hysitron scanning-nanoindenters (Triboscope and Bioindenter) with commercial and custom software to measure surface mechanical properties.

DESCRIPTION: Scanning tunneling microscopy/spectroscopy enables observation of the surface topography, chemical reactivity, and electronic structure of conductive substrates with atomic-scale resolution. The AFM provides nanometer-scale resolution of surface topography, mechanical properties, and tip-surface interaction forces on both conductive and insulating substrates. The tip-surface interaction forces, including frictional forces, can be measured with nanonewton (single chemical bond) precision. A new UHV system for nano-manipulation and nanoprobe characterization is also available in our new nanoscience building.

CONTACT:
Code 6177 • (202) 404-8845
LOCATION:
NRL, Washington, DC

Synchrotron Radiation Facility

Instrumentation and chamber on the NRL X24C beamline at the National Synchrotron Light Source, Brookhaven National Laboratory

FUNCTION: Studies the effects of ultraviolet (UV) radiation and X rays on solids and calibrates X-ray optics, detectors, and instruments.

DESCRIPTION: Research focuses on applying X rays to chemical and structural analysis of electronic and optical materials. Structural dynamics are monitored by diffraction carried out at the National Synchrotron Light Source (NSLS) or at major laser plasma X-ray sources, over time scales, from picoseconds to hours. Synchrotron and pump-probe laser techniques elucidate the electronic structure of the ground state, transiently excited states, and photo-transformed states in insulators, semiconductors, and molecular films.

INSTRUMENTATION:

- Beamline X23B provides intense, focused X-ray fluences from 3 to 11 keV with an energy resolution of 3×10^{-4}. Experimental equipment includes a four-circle Huber diffractometer and apparatus for transmission, fluorescence, and electron extended X-ray absorption fine structure (EXAFS).
- Beamline X24C provides intense, focused ultraviolet and X-ray fluences from 1 to 1800 eV with an energy resolution of 1×10^{-3} (delta E/E). There are three large ultrahigh vacuum (UHV) experimental chambers; a photoemission chamber, a reflectometer, and a Space Science and Plasma Diagnostic Instrument Calibration Facility.
- Beamlines X11A and X11B provide intense focused and unfocused X-ray fluence from 2 to 35 keV with an energy resolution of 2×10^{-4}. Experimental equipment includes apparatus for transmission and fluorescence EXAFS.
- Beamline U4B provides intense focused UV and fluence from 80 to 1200 keV with an energy resolution from 10^{-3} to 10^{-4}. Equipment includes UHV photoemission and reflectance experimental chambers.

CONTACT:
Code 6177 • (202) 767-4654
LOCATION:
NSLS • Long Island, NY

Ex-USS *Shadwell* Advanced Fire Research Ship

Ex-USS *Shadwell*

FUNCTION: Conducts full-scale fire/damage control experiments in a shipboard environment. This test platform can provide an integrated picture of the interactions of man, equipment, materials, tactics, doctrine, and systems in the development of fire protection/damage control concepts and technology, including the use of chemical simulants.

INSTRUMENTATION: The facility has extensive sensor and analytical sampling and analysis capabilities for measuring temperature, pressure, smoke obscuration, fluid flow, radiation flux, and total heat flux. There are video recorders for documentation of the fire tests and significant computing facilities for data collection, manipulation, and presentation. There is a 1-gigabit blown fiber network, which is tied into the data system, with 12-node rooms for input, output, and control of ship sensors and functions. This provides video coverage throughout the ship.

DESCRIPTION: Ex-USS *Shadwell* (LSD15) has an overall length of 457 ft, beam of 72 ft, and full-load displacement of 9000 tons. As a test bed, the ship contains one pressure zone to study smoke management, including a collective protection system (CPS) that has been created on all levels forward of frame 35. Selected ship systems that are important to fire protection and damage control, such as ventilation, electrical power, fluid distribution, fire mains, fire pumps, aqueous film forming foam (AFFF) proportioning system, and internal communications, have been reactivated. The ship has undergone major automation upgrades to its damage control systems. There is a high-pressure fine-water mist system over all decks forward of frame 35. Simulated on the ship are an aircraft carrier hangar bay, the forward section of a 688 submarine, one complete collective protection system of DDG51 and its simulated machinery space, LPD-17 well deck with ventilation, DDX flight deck and hangar, along with Peripheral Vertical Launch Systems (PVLS) and Automatic Gun System (AGS) magazines and LHAR's upper and lower vehicle storage area and well deck.

CONTACT:
Code 6180 • (202) 767-2476
LOCATION:
Little Sand Island, Mobile Harbor • NRL, Mobile, AL

Fire Research Enclosure

Submarine Fire Research Facility (FIRE I)

FUNCTION: Simulates submarine fires, enclosed aircraft fires, and fires in enclosures at shore facilities.

INSTRUMENTATION: The facility has over 200 sensors measuring pressure, temperature, radiation, total heat flux, and fire by-products. The data are collected, analyzed, and displayed in real time. Nitrogen-suppression pipes are embedded along the chamber walls. Thermocouples in the skin of the chamber record the effect of heat transfer to the chamber wall. The size and complexity of FIRE I require intricate safety considerations with built-in interlock systems. There are several television cameras to visually record the test fires.

DESCRIPTION: FIRE I is a pressurizable, 324-m^3 (11,400 ft^3) fire test facility that simulates a 1-quarter scale submarine compartment capable of pressurization to more than six atmospheres. This facility is used to study large-scale confined fires under controlled conditions and to test prototype equipment and fire-fighting agents. Two fixed fire-suppression systems for enclosures—nitrogen pressurization and preliminary water mist—have been tested.

CONTACT:
Code 6185 • (202) 404-8101
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Large-Scale Damage Control Facility

Large-Scale Damage Control Facility

FUNCTION: Performs large-scale fire protection experiments that simulate actual Navy platform conditions. Remote control firefighting systems are also tested.

INSTRUMENTATION: Specific instruments for these test beds are incorporated as a function of the particular experiment, but include sensors, gas sampling, control equipment, mixing vessels, calibrated fuel and aqueous flow metering, and video recording. The fire test building has a large cone calorimeter for full-scale fire tests of materials and furnishings.

DESCRIPTION: The facility consists of five buildings and three test beds. Two of the buildings are for enclosed fire experiments, qualification of firefighting agents, efficacy of dispensing these agents, and control and visibility through smoke. A third building is a staging area and a fourth is for storage. The fifth building contains a hydraulics laboratory and is equipped with a full-scale shipboard balanced pressure proportioner for aqueous film forming foam. A test bed simulates the lower section of a submarine for studying bilge fires and their extinguishment. A simulated 930 m^3 (10,000 ft^2) flight test bed is used to develop fire scenarios and suppression technologies. The third test bed has two test compartments, with internal volumes of 28 and 300 m^3 (1,000 and 10,500 ft^3), which are used for fire suppression experiments.

CONTACT:
Code 6185 • (202) 404-8101
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Materials Science and Technology Division

- Materials Processing Facility
- 3-MV Tandem Pelletron Accelerator
- Micro-Nano Structure Characterization Facility
- Mechanical Characterization Facility
- Electrical, Magnetic, and Optical Measurement Facility
- Thin Film Materials Synthesis and Processing Facility
- Magnetoelectronics Fabrication Facility

Materials Processing Facility

Isothermal Heat Treatment Facility

FUNCTION: Provides a full spectrum capability to synthesize and process materials, from small to large sizes, by a variety of methods and under varying thermal, mechanical, pressure, and rate-sensitive processes.

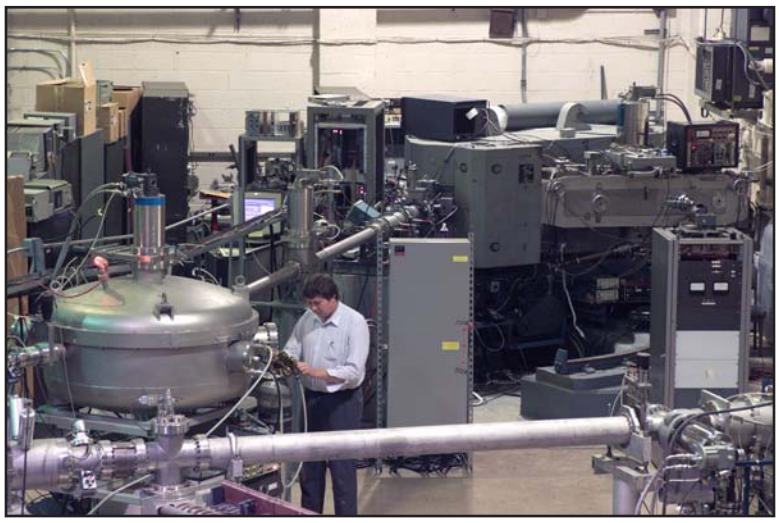
INSTRUMENTATION: Many of the facilities are modified versions of commercially purchased apparatus that have been adapted to the special needs of our research.

DESCRIPTION: Fully instrumented materials processing capabilities include facilities for powder production by fluid atomization, thermal evaporation, and arc erosion. These facilities offer the potential to create small particle sizes from 10 nm to 50 mm. The powder synthesis capabilities include a physical vapor deposition system designed to produce and coat submicron powders, in situ. Facilities to process powder into bulk specimens by hot and cold isostatic pressing permit a variety of consolidation possibilities. The isothermal Heat Treatment Facility and quenching dilatometer permit accurate determinations of phase relationships in metals. Arc melting facilities permit alloy synthesis and single crystal growth. Bulk alloys can be prepared by induction melting, while rapidly solidified metals of thin cross section can by made my splat quenching and melt spinning. The facility includes rolling mills, swaggers, and wire-drawing facilities. Metal-matrix composites and surface coatings are produced in a variety of computer-controlled, physical vapor deposition systems for coating fibers and surfaces. Ceramic and ceramic-matrix composite processing facilities include a wide variety of conventional, controlled atmospheric furnaces, hot presses, ball milling apparatus and particle size determination, and sol-gel and organometallic coating processing capabilities.

CONTACT:
Code 6320 • (202) 767-5799
LOCATION:
NRL, Washington, DC

3-MV Tandem Pelletron Accelerator

FUNCTION: Generates high-energy ions for accelerator mass spectrometry (AMS), near-surface analysis, high-energy ion implantation, and radiation-effects studies.



3-MV Tandem Pelletron Accelerator

INSTRUMENTATION: Four ion sources: (1) National Electrostatics Corporation (NEC) model Mutli-Cathode Source of Negative Ions by Cesium Sputtering (MC-SNICS) forty-cathode ion source; (2) custom multicusp gas-feed ion source under development for AMS; (3) front end of Cameca IMS 6f secondary ion mass spectrometer (SIMS); and (4) NEC Alphatross ion source to generate He ion beam. A unique Pretzel magnet coupled with an electrostatic analyzer (ESA) functions as a bandpass mass filter for the ion sources, covering a mass range from 1 to 240 amu. The tandem accelerator is an NEC model 9SDH-2 with a 3-MV terminal potential. An electrostatic bend selects the high-energy-ion charge state to be transmitted to the AMS beamline. This beamline provides mass-independent parallel transport through use of all electrostatic components, including a 45-deg spherical ESA with an E/ΔE of 800. Parallel mass analysis is performed with an Enge split-pole spectrograph having a 1.5-m-long focal plane covering a mass range of a factor of eight with an M/ΔM of about 2500. Intense beams are detected by well-shielded Faraday cups, weak beams are detected by position-sensitive micro-channel-plate detectors and energy detectors. Ions for non-AMS applications are transported through the spectrograph to a switching magnet that selects either (1) an analysis beamline with a variable-angle Si particle detector for Rutherford backscattering and elastic recoil detection analysis, manual and computer-controlled goniometers for ion channeling, and a 0.02 sr acceptance solid angle, double focusing, 180-deg magnetic spectrometer with 0.2% energy resolution; or (2) a high-energy ion implantation beamline for uniform ion implantation over a 4-in.-diameter wafer, with heating and water or liquid-nitrogen cooling of the sample. All beamlines have cryopumps or turbopumps for clean vacuum conditions.

DESCRIPTION: Negative ions are generated by Cesium (Cs) sputtering of a solid, or by attaching electrons onto neutral or positive ions by Cs or Rubidium vapour. Beam currents generated vary from μA to tens of μA depending on the source and ion chosen. Two "Pelletron" charging chains produce a terminal voltage up to 3 MV in the accelerator. Negative ions are injected at 10 to 70 keV, accelerated up to the terminal where they undergo collisions with a stripper gas or a carbon stripper foil and lose electrons, then are accelerated as positive ions back to ground potential. For AMS, the relative intensity of selected ions measures their concentration in the sample of interest located in the ion source. On the analysis beamline, the sample of interest is located at the end of the beamline, and a signal generated by scattering of incident high-energy ions indicates the composition of the sample. Incident high-energy ions can also be used to damage the surface of a sample of interest, or to introduce a dopant.

CONTACT:
Code 6303 • (202) 767-5738
LOCATION:
NRL, Washington, DC

Micro-Nano Structure Characterization Facility

Leo Scanning Electron Microscope (SEM) with Electron Backscatter Diffraction (EBSD) capability.

FUNCTION: Characterizes the internal micro-nanostructures of metallic, magnetic, electronic, and other multifunctional and structural materials using a variety of electron microscopy techniques.

INSTRUMENTATION: A JEOL 2010F transmission electron microscope (TEM); a Phillips CM30 TEM; and a Leo scanning electron microscope (SEM) with Electron Backscatter Diffraction (EBSD) capability.

DESCRIPTION: (1) JEOL 2010F TEM: A 200 KeV field emission TEM for sub-nanometer-scale analysis of structure and composition. Capabilities include: atomic resolution TEM, electron energy loss spectroscopy (EELS), energy dispersive spectroscopy (EDS), and scanning transmission electron microscopy (STEM) with atomic-resolution Z-contrast imaging, energy filtered imaging, electron holography, and spectrum imaging.

(2) Phillips CM30 TEM: A 300 KeV operating voltage TEM especially utilized for conventional TEM studies of advanced Naval steels requiring a large range of tilts for microstructural and defect analyses including conventional bright field and dark field imaging, weak beam dark field analysis, selected area diffraction, energy dispersive spectroscopy, and X-ray mapping. Capabilities include lattice imaging, EDS, and elemental X-ray mapping using an electron beam/image displacement attachment.

(3) Leo SEM with EBSD capability: SEM with a field emission gun (FEG) electron source. Capabilities include: High-resolution SEM, EDS, and a TexSem Laboratory (TSL) EBSD system with automated Orientation Mapping and quantification capabilities.

CONTACT:
Code 6324 • (202) 767-5799
LOCATION:
NRL, Washington, DC

Mechanical Characterization Facility

Mechanical Characterization Facility

FUNCTION: Characterizes the mechanical behavior of metal, polymer, ceramic, and composite materials under a variety of loading and environmental conditions using servo-hydraulic, electro-mechanical, and creep-load frames for use in advance material modeling and material response testing under simulated service conditions.

INSTRUMENTATION: Various load frames (5 to 550 kN): Instron 1332 (250 kN, 8800 controller), ATS 2330 (60 kN creep), Instron 4201 (SkN, screw-drive). ATS 3200 furnace (1000 °C), Instron 3119 chamber (-70 to 250 °C). Instron FastTrack (LaVIEW), Fracture Technology Associates (FTA) Crack Growth software. Thermal Analysis (TA) Instruments Dynamic Mechanical Analyzer (DMA 2980), Rheometer (AR-600), Differential Scanning Calorimeter/Thermogravimetric Analyzer (DSC/TGA) (SDT-2960), and Dielectric Analyzer (DEA 2970). GOM mbH ESPI 3-D laser speckle interferometer for 3-D strain measurement over an 2 x 4 in. area with sub-micron displacement resolution.

DESCRIPTION: The facility consists of various testing systems, many with automated computer control and data acquisition, for determining the mechanical response of materials under controlled loading/deformation and environmental conditions. Basic capabilities include quasi-static tensile and fracture testing; dynamic storage and loss moduli as a function of frequency and temperature; cyclic fatigue crack growth and corrosion fatigue testing; and stress-corrosion cracking testing. Fatigue crack growth rates can be determined under constant ΔP, ΔK, or K_{max} conditions. Horizontal 5-kip servo-hydraulic load frames are available for corrosion fatigue and stress-corrosion cracking experimentation in liquid environments.

CONTACT:
Code 6350 • (202) 404-8324
LOCATION:
NRL, Washington, DC

Electrical, Magnetic, and Optical Measurement Facility

Electrical, Magnetic and Optical Measurement Facility

FUNCTION: Provides tools necessary for electrical, magnetic, and optical characterization of bulk- and thin-film materials. This includes the ability to determine the resistivity as a function of temperature and magnetic field and the magnetization as a function of temperature using Superconducting Quantum Interference Devices (SQUID) and vibrating sample magnetometry. Electroluminescence facilities are also available for determination of the magneto-optic properties of light-emitting diode structures.

INSTRUMENTATION: Quantum Design Physical Properties Measurement System (PPMS): Temperature and magnetic field dependent measurements of transport, ac magnetic susceptibility, and heat capacity. Temperature range 200 mK to 350 K; magnetic field range ±8T. Quantum Design Magnetic Properties Measurement System (MPMS): Characterization of magnetic properties of materials by SQUID magnetometry; optical-fiber access for magneto-optic characterization. Temperature range 1.7 K to 400 K; magnetic field range ±5T; sensitivity less than 5 x 10^{-7} emu. Digital Measurement System's vibrating sample magnetometer: Magnetic materials characterization for magnetic fields up to ±2T, temperatures range from 110 K to 1000 K. Optical access flow cryostat/electromagnet system for magneto-electroluminescence measurements.

DESCRIPTION: This facility is comprised of several complementary instruments that allow for the magnetic, electrical, optical, and heat capacity characterization of materials and devices. SQUID and vibrating sample magnetometry are used to determine important properties of superconducting, para- and diamagnetic, and ferromagnetic materials. The transport properties of materials, namely the temperature and magnetic field dependent resistivity combined with heat-capacity measurements, allow for a fundamental physical understanding of electronic properties. The Vibrating Sample Magnetometer (VSM) extends the experimental temperature range of magnetic properties characterization to 1000 K. Measurements of luminescent properties of light-emitting devices under varying temperature and magnetic fields are also possible in this facility.

CONTACT:
Code 6360 • (202) 767-4694
LOCATION:
NRL, Washington, DC

Thin Film Materials Synthesis and Processing Facility

Thin Film Materials Synthesis and Processing Facility

FUNCTION: Provides a wide capability for deposition and processing of thin films, including sputter and ion-beam deposition, thermal evaporation, electro-deposition, pulsed-laser deposition, chemical vapor transport, and laser-direct write fabrication. These tools allow for thin-film growth of metals, dielectrics, oxides, solid electrolyte materials, and for laser patterning of thin-film structures.

INSTRUMENTATION: Dual-gun sputter system with backsputter clean: RF and dc magnetron deposition of metals and dielectrics. Kyocera high-temperature oxide sputtering system. Physical Electronics molecular beam epitaxy system. Eight Knudsen cell sources; Quadrupole Mass Analyzer (QMA) rate-monitor for sub-monolayer control of thickness; in situ Reflection High Energy Electron Diffraction (RHEED) and Auger analyzer. Pulsed Laser Deposition (PLD) System: multi-target PLD system using a 248 run excimer laser excitation with high-temperature stage and variable chamber atmosphere. Chemical vapor deposition furnace for growth of transition-metal oxides. Laser-direct write system for transfer of computer-aided design (CAD)-generated features to a wide variety of substrates and printed-circuit boards.

DESCRIPTION: This facility provides users a wide array of techniques for growth and processing of thin films (thickness 1μm or less). Sputter deposition offers a versatile method of depositing metallic and dielectric films and is a primary tool of this facility. Thermal evaporation of metals is implemented in both high-vacuum and ultrahigh vacuum systems. PLD with temperature variable stage temperature and controlled atmosphere allows growth of oxides. Electrolytic deposition offers efficient growth of gold and silver films. Laser direct write – both ablation and deposition – provide unique methods for imposing CAD-defined features via ablation of a substrate film and ablative mass transfer to a substrate.

CONTACT:
Code 6360 • (202) 767-4694 and 767-5653
LOCATION:
NRL, Washington, DC

Magnetoelectronics Fabrication Facility

Magnetoelectronics Fabrication Facility

FUNCTION: Provides a wide range of lithography tools for construction of micrometer and nanometer-size devices of interest in the study of magnetoelectronics.

INSTRUMENTATION: Karl Suss MJB3 mask aligner/contact printer with mid-ultraviolet (UV) optics capable of optical lithography to 500 nm resolution. Spin/bake/develop equipment for processing of photoresists and ebeam resists. Four-source thermal evaporation system; RF/dc magnetron sputter deposition system; ultrahigh vacuum (UHV) dual ion beam deposition system. CF4/02 reactive ion etching; Ar+ ion mill system; Wet etch process station. Olympus BXSO optical microscope with differential interference contrast imaging and camera; KLA-Tencor Alpha-step surface profilometer; Cascade Microtech REL-3200 manual probe station and electronic instrumentation rack; Kulicke and Soffa ultrasonic wire bonder. FEI, Inc. FIB-200 focused ion beam system equipped with enhanced etch, Pt-metal deposition, and dielec-

DESCRIPTION: The Magnetoelectronics Fabrication Facility is a Class 1000 cleanroom facility equipped with tools for lithographic construction of magnetoelectronic and spintronic devices. The facility provides pattern definition, metallization, dielectric layer deposition, and both reactive and Ar+ ion etching of wafers and small pieces.

CONTACT:
Code 6360 • (202) 767-4694
LOCATION:
NRL, Washington, DC

Laboratory for the Structure of Matter and Fluid Dynamics

- Parallel High-Performance Computer Graphics Facility

Parallel High-Performance Computer Graphics Facility

Parallel High-Performance Computer Graphics Facility

FUNCTION: The Laboratory for Computational Physics and Fluid Dynamics (LCP&FD) is in round-the-clock production for computational studies in the fields of compressible and incompressible fluid dynamics, reactive flows, fluid-structure interaction (including submarine, ship, and aerospace applications), plasma physics, atmospheric and solar magnetoplasma dynamics, application of parallel processing to large-scale problems such as unstructured grid generation for complex flows, and other disciplines of continuum and quantum computational physics.

INSTRUMENTATION: The SGI computer systems are comprised of a 64 Itanium 2 processor SGI Altix, a 12 Itanium 2 processor SGI Altix, a 28 R12K processor Origin 3800, an 8 R14K processor Origin 350, and an 8 R12K processor Origin 2000. There are two 256 x86 processors well coupled with Myrinet high speed switched interconnect. Each system has on the order of 200 GB of disk for storage during a simulation, and at least 512 MB of memory per processor.

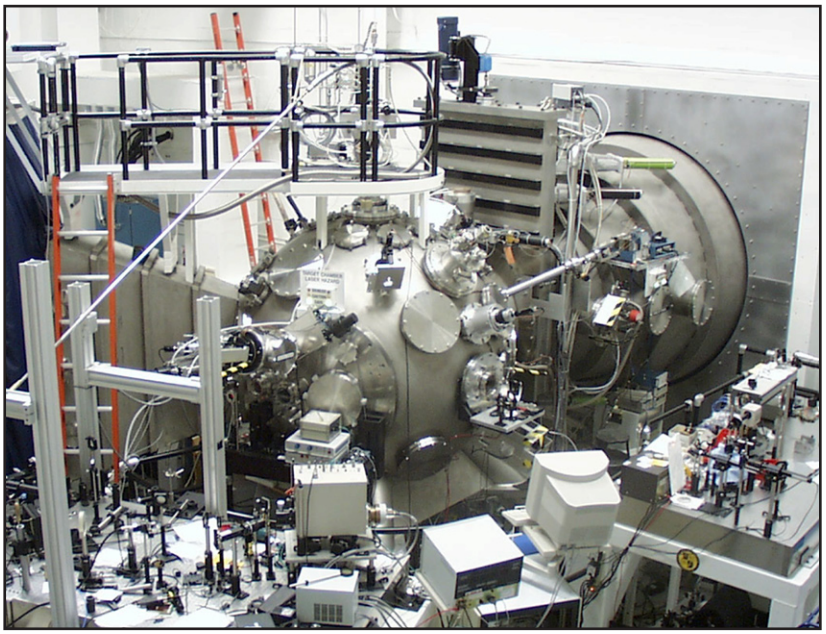
DESCRIPTION: The facility is used to develop and maintain state-of-the-art analytical and computational capabilities in fluid dynamics and related fields of physics, to establish in-house expertise in parallel processing and on-line graphical rendering for large-scale scientific computing, to perform analyses and computational experiments on specific relevant problems, and to transfer this technology to new and ongoing projects through cooperative programs. LCP&FD maintains a very powerful collection of computer systems. There is currently a total of 120 parallel SGI processors, 512 clustered x86 processors, and several other support systems. In addition, there are over 50 Macintosh computers, most of which are capable of large calculations both independently and in parallel ad hoc clusters.

CONTACT:
Code 6440 • (202) 404-1063
LOCATION:
NRL, Washington, DC

Plasma Physics Division

- Nike KrF Laser Facility
- Electra Laser Facility
- Pharos Laser System
- Large Area Plasma Processing Systems
- Space Physics Simulation Chamber
- Gamble II
- Hawk
- Mercury
- High-Frequency Microwave Processing of Materials Laboratory
- T-Cubed Laser System
- TFL Laser System

Nike KrF Laser Facility



Nike Target Chamber

FUNCTION: Studies the physics and technology issues of direct-drive laser fusion. Primary areas of research include studies of means to reduce hydrodynamic instability in laser-accelerated targets, studies of the response of materials to extreme pressures, and generation of X rays from laser-heated targets. This work supports the Department of Energy's program for science-based stockpile stewardship.

INSTRUMENTATION: A computer-controlled data acquisition system, high-speed X ray and optical cameras, high-resolution X-ray imaging systems, X-ray and visible spectrometers, high-speed digital oscilloscopes, and cryogenic target capability.

DESCRIPTION: The Nike laser is a 56-beam krypton fluoride (KrF) system that provides 3 to 4 kJ of laser energy on targets. The laser uses controlled spatial incoherence to achieve highly uniform focal distributions in each of these beams. Up to 44 of the beams are overlapped onto targets with typical focal diameters of 0.75 mm and peak intensities near 10^{14} W/cm^2. The combination of uniform individual beams and smoothing from overlapping numerous beams produces extremely uniform illumination of targets. The effective illumination nonuniformity is less than 0.2% when time averaged over a typical 4-ns laser pulse. Nike thereby produces highly uniform ablation pressures on target that allow well-controlled experiments at pressures up to 20 million atmospheres. The remaining 12 laser beams are used to generate diagnostic X rays that radiograph the primary laser-illuminated targets. The facility includes a front end that generates the desired temporal and spatial laser profiles, two electron-beam pumped KrF amplifiers of 20 and 60 cm aperture, a computer-controlled optical system consisting of approximately 400 mirrors, and a vacuum target chamber for experiments.

CONTACT:
Code 6730 • (202) 767-0689
LOCATION:
NRL, Washington, DC

Electra Laser Facility

Electra Laser Facility

FUNCTION: The Electra Laser Facility is used to develop the science and technology needed to develop a reliable, efficient, high energy, repetitively pulsed krypton fluoride (KrF) laser. The main application for this laser is as a driver for fusion energy power plant. However, the laser architecture also has defense applications.

INSTRUMENTATION: The operation of the Electra facility is carried out through a computerized control system that continually monitors all system parameters. This includes the input, inter-stage, and output voltages, magnetic current, trigger laser operation, gas, electrolyte, and coolant temperature and flow. A totally separate system is used to acquire data from the experiment, including electron beam voltage and current, laser gas parameters, laser output, and laser pulse shape.

DESCRIPTION: Electra produces a stream of 700 J, 100-ns-long pulses of laser light in 1-Hz and 5-Hz bursts for several hundred shots. The amplifier is pumped with two 450,000-V, 100,000-A electron beams. Each beam is 30 cm high by 100 cm long. The electron beams excite a krypton-fluorine gas mixture inside a laser cell. A thin foil supported by a structure known as a hibachi, isolates the vacuum regions in which the electron beams are formed, from the gas inside the laser cell. A recirculator both cools and quiets the laser gas between shots. As a result of the research program, this type of laser is predicted to have total efficiencies of greater than 7%. This is due to advances in the electron beam physics, the laser physics, and the hibachi. A new solid-state pulsed power switch has been developed, which can become the basis for a durable, efficient, and cost-effective pulsed power system. The main outstanding challenge is to develop a long-lived hibachi. This is believed to be a matter of efficiently cooling the foils, and preliminary studies show the foil can be kept cool by deflecting the laser gas between shots.

CONTACT:
Code 6730 • (202) 767-2705
LOCATION:
NRL, Washington, DC

Pharos Laser Facility

Pharos Laser Facility

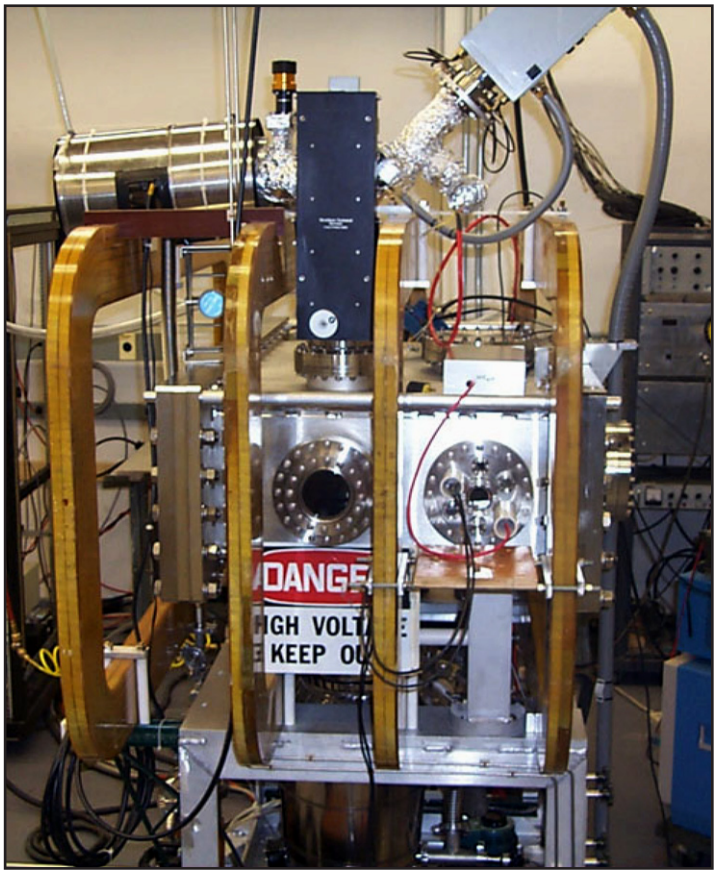
FUNCTION: Conducts high-power, short-pulse, laser-plasma, and laser-solid interaction studies that include nuclear blast effects simulation, shock wave generation, interaction in solids and plasmas, and shock wave and explosive cavitation interaction in water and water-saturated seabed sands.

INSTRUMENTATION: A large variety of laser-plasma diagnostics are available. These include time-integrated visible and X-ray spectrographs and beam diagnostics as well as high-speed drum cameras, ultra-high-speed gated optical imagers, streak cameras, and single-channel detectors sensitive to both visible and X-ray wavelengths. Several specially designed lower power lasers are also available as probes for optical diagnostics.

DESCRIPTION: The facility consists of the Pharos laser with associated target chambers and dedicated diagnostics. Pharos is a Nd:Glass laser that provides two 15-cm clear aperture beams of 1-μm wavelength light. Each beam can deliver more than 500 J of energy on target in a 5-ns pulse. The system repetition rate at full energy is once every 50 minutes. Each of the beams may be independently targeted and independently timed. Harmonic generation crystals can be used to convert the laser's output from 1.0 to 0.5 μm wavelength. The system has recently been relocated to a new, improved laboratory space.

CONTACT:
Code 6730 • (202) 767-9117
LOCATION:
NRL, Washington, DC

Large Area Plasma Processing System (LAPPS)



Source chamber for
Large Area Plasma Processing System

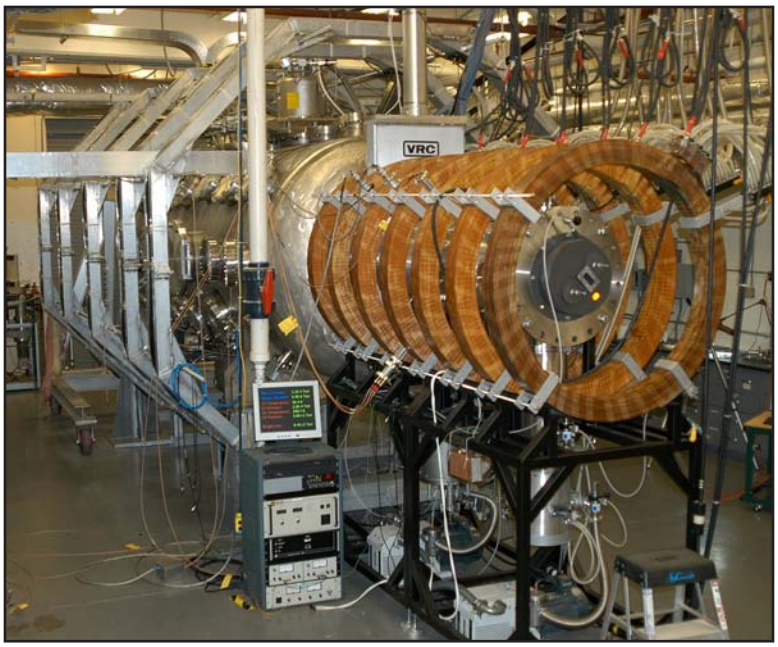
FUNCTION: Studies beam-generated plasmas for materials processing applications. Independently generated kV electron beams pass through the chamber confined by an axial magnetic field and ionize the background gas. The low-temperature, high-density, uniform plasma sheet can be positioned close to a surface to be processed. The NRL-developed Large Area Plasma Processing System (LAPPS) can generate square meter plasmas with higher efficiency and better control than other techniques presently used in materials processing.

INSTRUMENTATION: A variety of plasma and particle collection diagnostics are used. These include Langmuir probes to measure plasma density, plasma potential, and temperature; biased charge collectors to measure local ion densities and plasma potential; a combination particle energy analyzer and quadrupole mass analyzer to identify particles and determine their energy; optical diagnostics to measure plasma temperature and composition; and a laser-induced fluorescence system for measuring local particle energies. A large number of ports were built into the chamber to facilitate diagnostics.

DESCRIPTION: The ultrahigh vacuum chamber shown is filled with a process gas. The large field coils are used to generate 100- to 300-G magnetic fields along one axis, which confine a 1- to 3-kV, few milliamperes per square centimeter electron beam. A surface located inside the chamber can be moved close to the plasma sheet generated by the beam. Materials such as semiconductors to be etched or dielectrics to be coated can be mounted on the surface for processing by the plasma. The ports are used for diagnostics to measure beam, plasma, or surface conditions.

CONTACT:
Code 6750 • (202) 767-7532
LOCATION:
NRL, Washington, DC

Space Physics Simulation Chamber (SPSC)



Space Physics Simulation Chamber

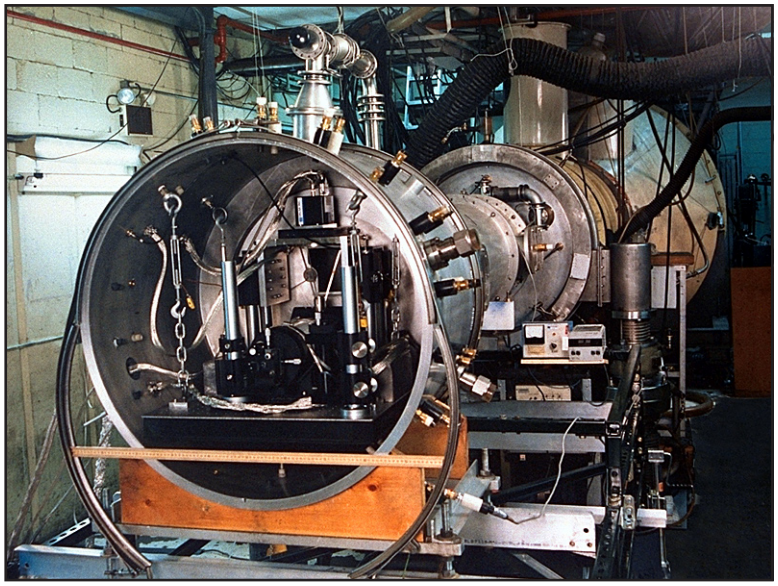
FUNCTION: Simulates near-Earth space environment under controlled, reproducible conditions. The SPSC is used to study ionospheric, magnetospheric, or solar wind plasma phenomena, testing/calibration of space-qualified diagnostic instruments to be launched on orbital or suborbital missions, spacecraft charging, large-volume plasma generation, and other topics requiring a low-pressure environment.

INSTRUMENTATION: A full range of plasma diagnostics is available, including internally heated Langmuir probes, emissive probes, ion energy analyzers, ac magnetic field probes, and pressure probes. Numerous transient recorders, power supplies, digital multimeters, electrometers, and amplifiers are available. The instrumentation is General Purpose Interface Bus (GPIB)-controlled using LabVIEW™ software.

DESCRIPTION:The SPSC is a 1.8-m-diameter, 5-m-long stainless steel vacuum vessel containing numerous access ports. Dual cryogenic vacuum pumps maintain SPSC base pressure near 10^{-7} torr. Five magnetic field coils provide a uniform dc axial magnetic field up to 50 G. An additional 2 m of plasma column length are provided by the new 0.55-m-diameter source chamber section along with the ability to achieve steady-state magnetic fields ranging from 0 to 1000 G levels. The SPSC is equipped with two large-volume plasma sources (plasma column diameter ~0.5 m): (1) a microwave discharge plasma source (plasma densities ranging from 10^5 to 10^9 cm^{-3} and electron temperatures of ~0.5 eV) and (2) a large-area thermionic discharge plasma source (plasma densities ranging from 10^5 to 10^{12} cm^{-3} and electron temperatures ranging from 0.1 to 2 eV). Access for electrical, diagnostic, and manipulator vacuum penetration is available over most of the SPSC volume. The SPSC is also equipped with an internal 3-D positioning system capable of probing nearly the entire volume of the plasma column.

CONTACT:
Code 6755 • (202) 404-1022
LOCATION:
NRL, Washington, DC

Gamble II



Gamble II

FUNCTION: Produces high-voltage (3 MV), high-current (> 1 MA), short (< 100 ns) pulses of energy of either positive or negative polarity. These terawatt power level pulses are used for many Navy, DoD, and DOE programs including nuclear weapons effects simulation, ion beam production studies for inertial confinement fusion, particle beam production and focusing for directed-energy weapons, and dense Z-pinch production for X-ray laser research. The device also serves as a test bed for advanced pulsed power research on opening switches.

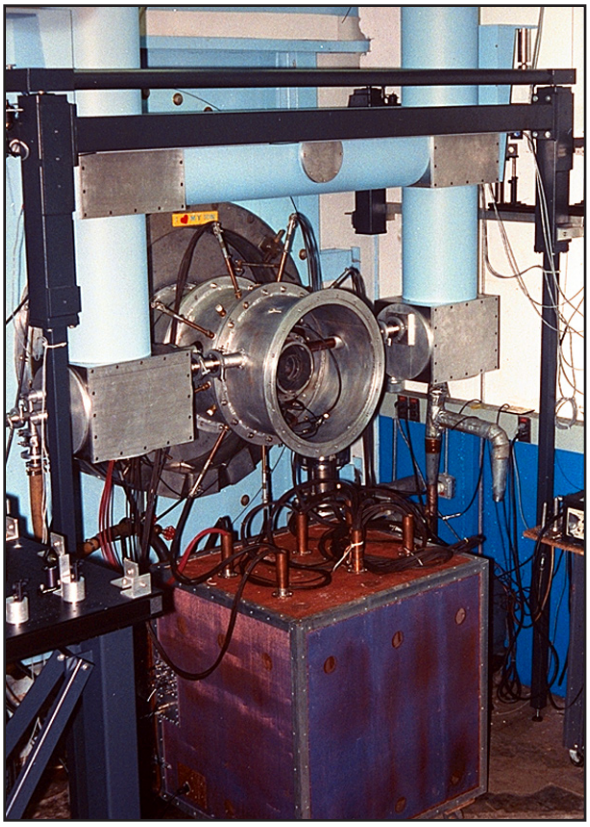
INSTRUMENTATION: Diagnostics for the generator and the beams are monitored in a shielded room located outside the radiation area. Diagnostics include sophisticated computer-controlled transient recorders or oscilloscopes to record analog signals, numerous optical, X-ray, or neutron diagnostics, and nuclear activation monitors.

DESCRIPTION: The facility's 300-kJ Marx generator is a large capacitor bank capable of producing several megavolt voltages. The voltage pulse is then compressed in time duration through a succession of water dielectric pulse-forming lines separated by closing switches to eventually arrive as a high-power pulse across a vacuum diode. This pulse can be applied directly across a load (such as a gas column or wire) or can be used to produce powerful electron or ion beams. These high-power beams are then allowed to interact with X-ray converters or to propagate to a variety of targets. The facility is surrounded by thick concrete shielding to contain X rays produced as a result of the high-power pulses.

CONTACT:
Code 6770 • (202) 767-8373
LOCATION:
NRL, Washington, DC

Hawk

Hawk



FUNCTION: Produces a high-current (750 kA) pulse with a microsecond rise time into a vacuum inductor. The energy stored in the inductor is transferred to a radiation or particle-beam load by using a plasma opening switch (POS). These inductive energy store (IES) generators represent a new approach for generating high-power pulses for Navy, DoD, and DOE applications, including nuclear weapons effects simulation, inertial confinement fusion, and dense Z-pinch X-ray sources. The device is used primarily as a research test bed for IES technology and for fundamental research into the physics of POS operation.

INSTRUMENTATION: Diagnostics for the generator and POS are monitored in a shielded room located outside the radiation area. Diagnostics include sophisticated computer-controlled transient recorders to record analog signals, various optical, X-ray, and nuclear activation monitors, and plasma diagnostics, such as interferometers and charged particle detectors for measuring quantities of interest in the POS.

DESCRIPTION: The facility consists of four Marx banks in an oil-filled tank, connected in parallel, with an output voltage of 720 kV when the capacitors are charged to 90 kV each. The Marx bank stores 300 kJ of electrical energy. The discharge of the capacitors into the system inductance (700 nH) results in a sinusoidal current with a 1.2-μs quarter period and an amplitude of 750 kA. A POS is used to conduct the generator current during most of this rise time (typically for about 1 μs) while the energy is transferred from the capacitors to the circuit inductance. The POS then opens quickly (in less than 100 ns) allowing the current to flow to a downstream load, for example, an electron-beam diode. The facility is surrounded by thick concrete shielding to contain X rays produced as a result of the high-power pulses.

CONTACT:
Code 6770 • (202) 404-8984
LOCATION:
NRL, Washington, DC

Mercury

Mercury

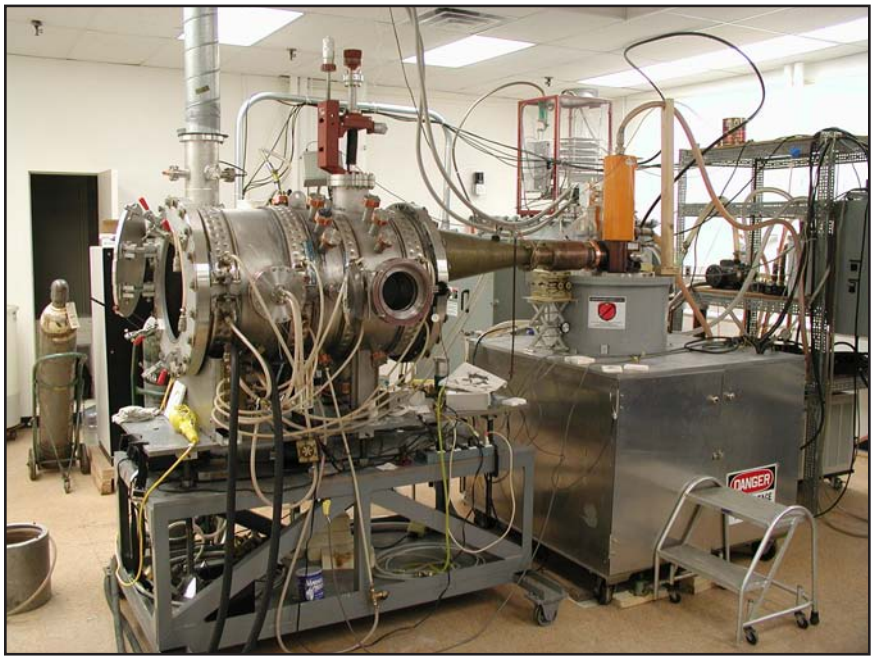
FUNCTION: Mercury is the newest pulsed-power generator facility. It is a state-of-the-art 6-MV, 375-kA, 50-ns, 2.2-TW magnetically insulated inductive voltage adder (IVA). Mercury will be a focal point of research for several areas. These areas include: IVA power-flow research and development, X-ray source development for both high-resolution flash radiography (in support of the US Stockpile Stewardship Program) and nuclear weapons effects simulation, and particle-beam source and transport research for various applications.

INSTRUMENTATION: A full array of electrical diagnostics is monitored on a bank of transient recorders in an electrically shielded room located outside the radiation-shielded area. Complementing the electrical diagnostics is a full set of time-resolved and time-integrated radiation diagnostics, as well as state-of-the art interferometric diagnostics. The generator operation is computer controlled.

DESCRIPTION: Mercury is a 6-stage IVA. The oil-immersed Marx bank comprises 36, 2.2-μF, 100-kV capacitors (396 kJ at 100-kV charge). The erected Marx discharges into four, parallel, coaxial water capacitors, also immersed in oil, that make up the 36-nH intermediate-store (IS). Each IS discharges into three, 5.5-Ω, coaxial, water-pulse-forming lines (PFLs) through a laser-triggered gas switch. Each of the 12, 50-ns-long (two-way transit time) PFLs is switched out through self closing, water output switches into a coaxial, water output line that connects the PFL to an induction cell through a coaxial, oil-filled elbow. Two PFLs feed each of the six induction cells, one from the top and one from the bottom. The voltage on each induction cell is added up in vacuum along a magnetically insulated transmission line to obtain the final voltage. Thick concrete walls surround the generator to contain X rays.

CONTACT:
Code 6770 • (202) 404-8984
LOCATION:
NRL, Washington, DC

High-Frequency Microwave Processing of Materials Laboratory



High-Frequency Microwave Processing of Materials Laboratory

FUNCTION: Conducts research on high-frequency microwave processing of materials using a high-power, continuous-wave (CW) 83-GHz, quasi-optical beam system for rapid, selective sintering, heat treatment, modification, coating and joining of ceramics and metals, and production of nanocrystalline metals and ceramics.

INSTRUMENTATION: The Gycom, Ltd. 15-kW gyrotron and associated dc power supply and cryogen-free, superconducting 3 T magnet are controlled and monitored by a LabVIEW™ PC-based system that acquires and analyzes a wide range of instrumentation output and includes a large number of safety interlocks. Workpiece temperature diagnostics include single and two-color pyrometers, and up to 8 K- and S-type thermocouples. Processes can be monitored in real time and recorded via a video camera within the processing chamber.

DESCRIPTION: A free-space propagating, quasioptical beam of intense polarized millimeter-wave radiation is produced by an 83-GHz, 15-kW CW industrial gyrotron and injected into a stainless steel processing chamber (1-m-long × 0.65-m-diameter) where it is focused onto the workpiece. Beam intensities up to 0.1 megawatt per square centimeter can be achieved, the beam power is variable up to 15 kW, and the pulse length is variable from 1 second to continuous wave operation. Minimum spot size (0.5 cm), area illumination (20 × 20 cm), and strip illumination (0.5 × 20 cm) of the workpiece can be achieved using focusing mirrors. Various processing atmospheres can be used and workpieces can be heated rapidly to temperatures exceeding 2000 °C.

CONTACT:
Code 6793 • (202) 767-2469
LOCATION:
NRL, Washington, DC

T-Cubed Laser System

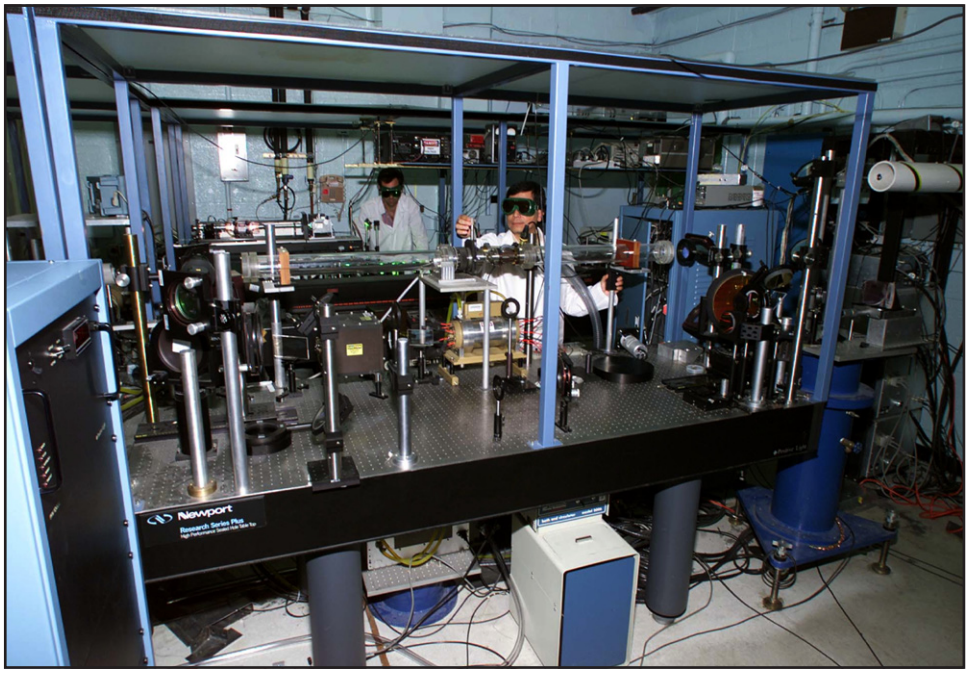


Table-Top Terawatt Laser

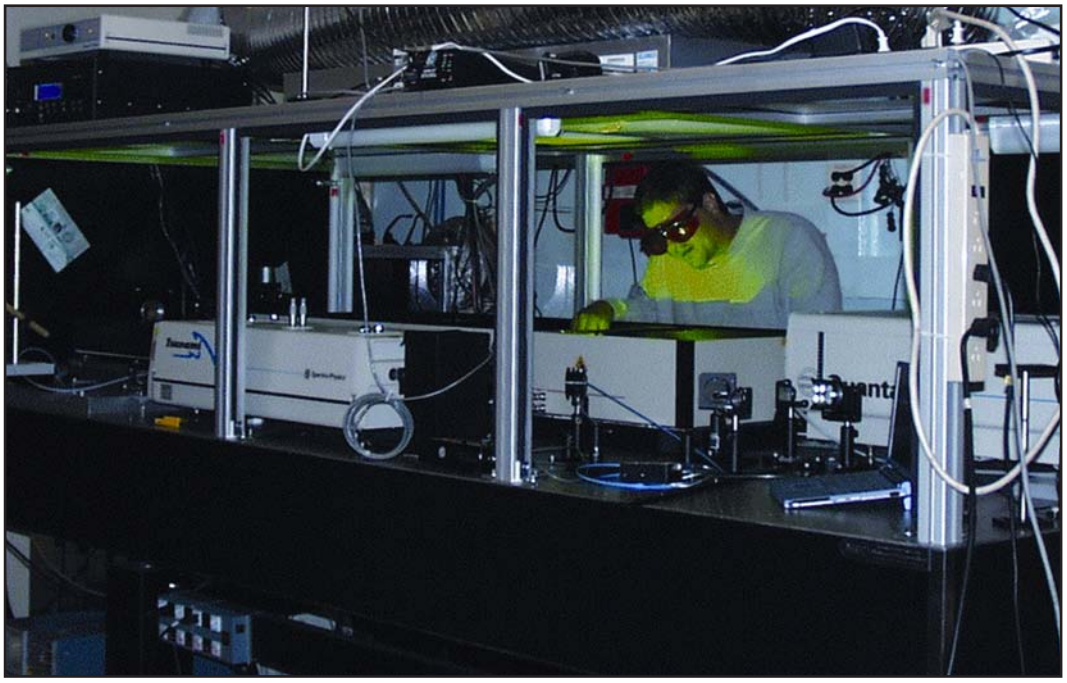
FUNCTION: Conducts ultrahigh-power, ultrahigh-intensity laser-plasma, laser-electron beam, and laser-solid interaction studies that include fundamental strong-field physics experiments, and new imaging and diagnostic techniques.

INSTRUMENTATION: A large variety of laser plasma and electron beam diagnostics are available. These include laser diagnostics, autocorrelators, FROG (frequency resolved optical gating), interferometers, optical and X-ray spectrometers, optical and X-ray streak cameras, gated optical imagers, infrared linear and 2-D sensor arrays, X-ray diodes, and magnetic electron spectrometers. Several lower power lasers are also available as probes for optical diagnostics.

DESCRIPTION: The facility consists of the T-Cubed (Table-Top-Terawatt) laser with associated target chambers and diagnostics. The T-Cubed Laser System uses chirped pulse amplification of 1.053 μm wavelength light. It can provide >8 J of energy in a 400-fs pulse using a vacuum optical compression chamber, thus providing pulsed power greater than 20 TW. The excellent beam quality of the amplified light provides focused intensities ~10^{19} W/cm^2 on target. The laser pulse also has high contrast ratio so that plasma formation due to prepulse illumination of the target can be minimized. The system repetition rate at full energy is once per 20 min without degrading the beam quality. Optical compression in air can deliver 1 J energy pulses at a rate of once per 5 min. Frequency-doubled pulses at 527 nm wavelengths can be obtained at ~70% efficiencies.

CONTACT:
Code 6795 • (202) 404-7568
LOCATION:
NRL, Washington, DC

TFL Laser System



Titanium:sapphire Femtosecond Laser

FUNCTION: Conducts experimental studies of femtosecond, intense laser-pulse interactions with nonlinear media such as propagation and breakdown in air and water, novel radiation generation for remote sensing and countermeasures, and nonthermal material modifications.

INSTRUMENTATION: A large variety of laser and plasma diagnostics are available. These include autocorrelators, FROG (frequency-resolved optical gating), a gated optical imager, interferometers, streak cameras, imaging spectrometers, linear and 2-D optical image intensifiers, linear and 2-D infrared detectors, X-ray spectrometers and detectors, and several pulsed and continuous wave (CW) probe lasers.

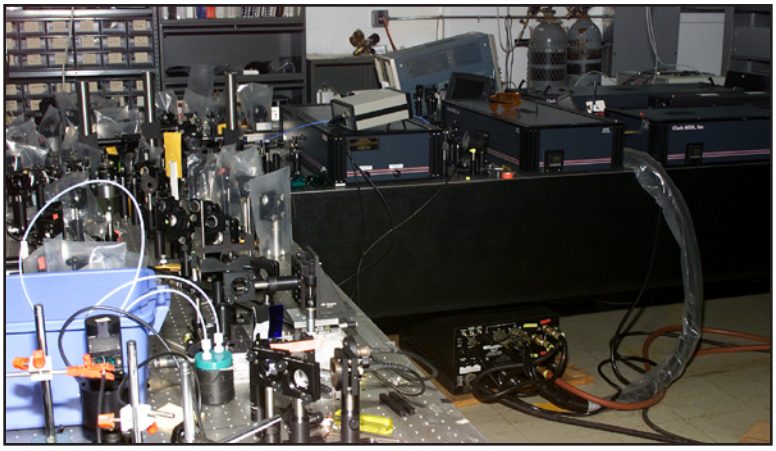
DESCRIPTION: The facility consists of the Titanium: sapphire Femtosecond Laser (TFL) with the associated interaction chambers and diagnostics. It operates at a repetition rate of 10 Hz and a laser wavelength of 0.8 μm. The laser-pulse length is 50 fs and the pulse energy is 40 mJ, providing ~1 TW of pulsed-laser power. It is being upgraded to 0.4 J of pulse energy and ~10 TW operation. The final compression of the output laser pulse is separated from the laser amplifiers to provide multiple beamlines for convenient switching between experiments. Frequency doubling of the laser provides unique femtosecond laser pulses at 0.4 μm for underwater propagation studies.

CONTACT:
Code 6795 • (202) 404-7568
LOCATION:
NRL, Washington, DC

Electronics Science and Technology Division

- Ultrafast Laser Facility
- Space Solar Cell Characterization Laboratory
- Vacuum Electronics Fabrication Facility
- Compound Semiconductor Processing Facility
- The MOCVD Laboratory
- Epicenter for Advanced Materials Growth and Characterization

Ultrafast Laser Facility (ULF)



The amplified titanium sapphire system for investigating ultrafast processes in condensed matter systems

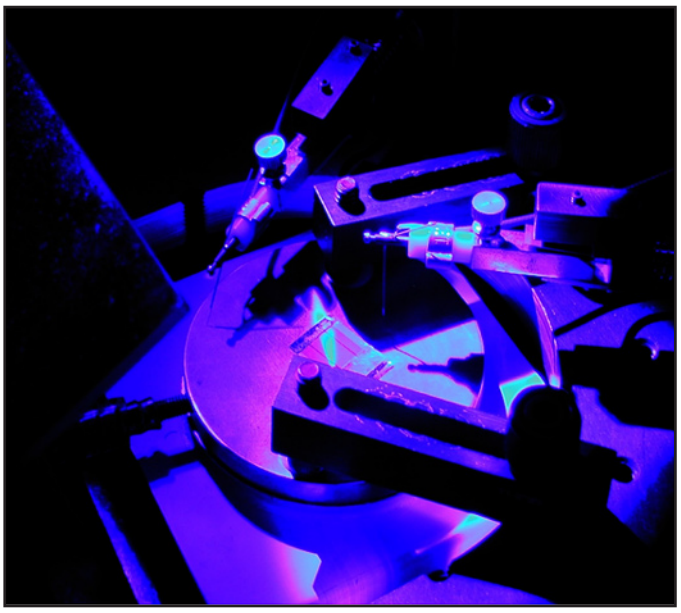
FUNCTION: Supports a broad range of basic and applied research that include understanding primary photophysical processes in molecular and supermolecular systems, characterizing the nonlinear optical response of nanoscale materials, and simulating the effects of space radiation with state-of-the-art microelectronics circuitry. The ULF supports NRL 6.1 research programs and collaborative research projects with outside university and government institutions. Customers from the space electronics industry use the ULF as a tool to optimize circuit designs for space applications.

INSTRUMENTATION: The ULF contains laser systems capable of producing laser pulses in a temporal range between 20 fs and 100 ps. The core femtosecond system consists of an amplified titanium sapphire laser that is coupled to an optical parametric amplifier. This system generates tunable femtosecond pulses from the mid-infrared to the ultraviolet portions of the spectrum. A second femtosecond titanium sapphire oscillator is available for applications requiring high pulse repetition rates. The ULF also maintains a synchronously pumped cavity-dumped dye laser system, which produces picosecond pulses in the visible and near-infrared. A time-correlated photon counting apparatus provides a sensitive measurement of fluorescent signals. The ULF has the optical apparatus and spectroscopic instrumentation to perform a wide variety of ultrafast and nonlinear optical experiments.

DESCRIPTION: The ULF's equipment has recently been used to perform experiments that measure ultrafast photophysical processes in organic macromolecules, dendrimers, and in nanoscale organic/inorganic hybrid materials. An optical apparatus has been configured to characterize photophysical mechanisms using transient pump-probe spectroscopy at either a single frequency, or using a multicolor continuum probe. A separate apparatus is dedicated to characterizing the magnitude and temporal response of the nonlinear optical susceptibility of semiconductor nanoparticles and novel polymer-based materials. The ULF also supports research in "coherent control," where the phase and amplitude properties of the laser field are used to control the light-matter interaction. The ULF is also devoted to understanding the effects of space radiation on microelectronics circuitry. Picosecond laser pulses are used to simulate the interaction of space radiation with semiconductor material (Si, GaAs, InAs, etc.). The picosecond pulsed laser permits the study of space-radiation effects in microelectronics in a highly controlled manner, and, thus, complements experiments performed at accelerator facilities. The ULF has proven invaluable to the space industry for troubleshooting microelectronic circuits for space applications.

CONTACT:
Code 6812 • (202) 767-5461
LOCATION:
NRL, Washington, DC

Space Solar Cell Characterization Laboratory



Triple junction, amorphous silicon solar cell under colored light bias mounted in the NRL spectral response measurement system

FUNCTION: Measures, characterizes, and analyzes photovoltaic materials and devices. The primary focus is the measurement and characterization of solar cell response to exposure to natural and man-made radiation environments. These facilities are used by a range of customers, both commercial and government, for performing experiments ranging from in-depth basic studies of radiation response mechanisms to large-scale product qualification campaigns.

DESCRIPTION: The solar cell laboratory facility is unique in its combination of measurement, analysis, and modeling capabilities. The laboratory contains the in-house expertise to assess a photovoltaic technology, design and implement the most effective characterization test plan, and analyze the results to produce an in-depth materials characterization and device performance evaluation. Furthermore, using the displacement damage dose analysis technique developed within the laboratory, the experimental results can be rapidly translated into accurate predictions of device performance in essentially any radiation environment, particularly that of Earth orbit.

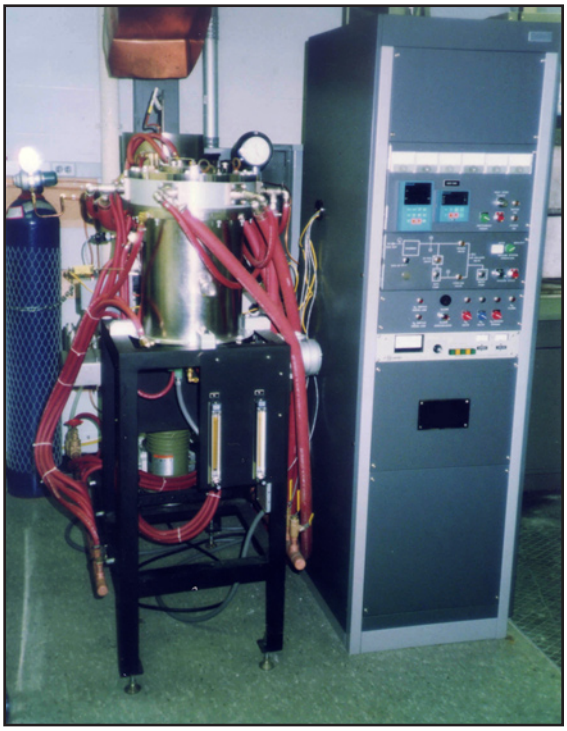
MEASUREMENT CAPABILITIES: The solar cell laboratory boasts a wide array of measurement capabilities. The central feature is a TS Space Systems Triple-zone, CloseMatch Simulator that has three independently controllable light zones – 300 to 700 nm, 700 to 1200 nm, and 1200 to 2400 nm – that produces one sun, air-mass zero (AM0) illumination with 2% uniformity over a 28-in^2 area with better than 0.5% spectral fidelity from 300 to 2400 nm. In addition, the laboratory contains a Spectrolab X-25 Mark II solar simulator providing one sun, AM0 illumination with 2% uniformity over a 78-in^2 area with 2% spectral fidelity from 300 to 1600 nm. The laboratory also contains a custom built spectral response system ranging in wavelength from 340 to 2400 nm with specialized light an electrical biasing configuration allowing individual subjunction measurements within multijunction devices to be measured. The laboratory also contains diode dark-current measurement systems, a deep-level transient spectrometer, an electrochemical capacitance-voltage profiler, and a state-of-the-art Hall Effect System.

RADIATION FACILITIES: NRL maintains in-house radiation facilities and has long-standing relationships with facilities at many other government laboratories, providing access to virtually any desired radiation test environment. Focusing on the natural space radiation environment, NRL has established specialized test chambers enabling exposure of multiple, large-area solar cells to electron and proton irradiation over a wide range of particle energies and fluxes.

CONTACT:
Code 6818 • (202) 767-2533
LOCATION:
NRL, Washington, DC

Vacuum Electronics Fabrication Facility (VEFF)

High-purity vacuum/hydrogen/nitrogen furnace for brazing, heat treating, and ceramic metallizing operations in the 600 to 1700 °C temperature range



FUNCTION: Provides electrical and mechanical design, fabrication, assembly, modification, and repair, as well as processing services for vacuum electronic devices. The VEFF also maintains support equipment primarily for the Tri-Service vacuum electronics research and development programs conducted at NRL as the lead laboratory.

INSTRUMENTATION: The VEFF operates and maintains a high-vacuum laboratory and processing facilities that encompass furnace, chemical, computer-aided design, high-vacuum processing, precision assembly, and precision machining facilities, all of which are fully equipped with state-of-the-art processing equipment.

DESCRIPTION: VEFF staff collaborates with principal investigators, obtaining theoretical design data and initiating the experimental device production process. VEFF engineers then produce assembly and detail parts drawing packages and coordinate a broad spectrum of shop activities to produce unique vacuum electronic components. In-house preparation of these specialized components includes heat treatment, surface preparation, microcleaning, vacuum firing, brazing, and extensive quality assessment. Leak-tight joining of high-purity alloys and refractory metals and ceramics is accomplished using brazing, welding, diffusion bonding, and other specialized processes. Specialized fixtures and jigs are fabricated where required. Completed experimental assemblies are evacuated, baked out, and delivered to the investigator's lab, ready for experimentation. Since 1980, the VEFF staff has been called on to provide expertise and equipment to repair, overhaul, or modify various experimental or commercially produced microwave or millimeter-vacuum electronic devices.

CONTACT:
Code 6843 • (202) 404-2799
LOCATION:
NRL, Washington, DC

Compound Semiconductor Processing Facility

Compound Semiconductor Processing Facility

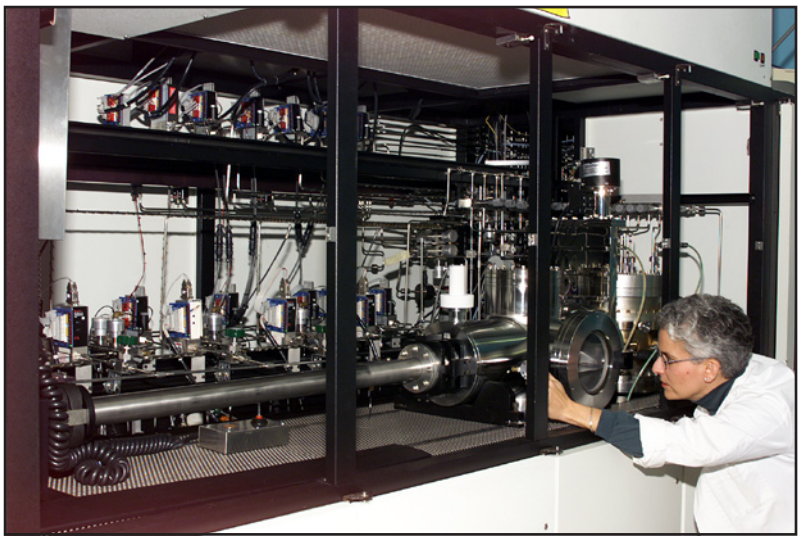
FUNCTION: Provides a research environment for hands-on fabrication of novel structures for fundamental investigations of new compound semiconductor materials, devices, and circuit concepts. Also, provides a service facility for electron-beam lithography, scanning electron microscopy and fabrication of devices and circuits.

INSTRUMENTATION: Principal capabilities include (1) standard photolithography-photoresist spinner and bake ovens, microscope, mask aligners operating in the mid-ultraviolet (UV) and deep-UV (DUV) range, and a DUV flood exposure system; (2) metallization—e-beam evaporation for standard metals; (3) dry etching—reactive ion etching (RIE), inductively coupled plasma (ICP), and plasma etching; (4) silicon nitride deposition—plasma enhanced chemical vapor deposition; (5) fine line patterning via electron-beam lithography; (6) scanning electron microscopy; and (7) other capabilities—contact alloying, profilometer, rapid-thermal-annealing (RTA), annealing furnaces, and gold plating.

DESCRIPTION: The facility consists of a 1500-ft^2 clean room area (Class 10,000) with HEPA filtration, temperature/humidity control, and an independent air handling system with single-pass capability. A full-time technician is assigned to the facility for maintaining the equipment, training new users, and assisting the hands-on users on specialized runs. State-of-the-art microwave and optoelectronic devices are processed in the facility using gallium arsenide, gallium nitride, and indium phosphide material systems. Lines with features size as small as 20 nm can be fabricated with a Raith e-beam microscope.

CONTACT:
Code 6852 • (202) 404-4616
LOCATION:
NRL, Washington, DC

The MOCVD Laboratory



A MOCVD reactor in the MOCVD Laboratory

FUNCTION: NRL's primary site for the exploration of crystal growth via metal-organic chemical vapor deposition (MOCVD). Current research activities include the growth of wide bandgap semiconductor materials and device structures for use in power electronics, RF communications, and radar. The materials used in this activity are gallium nitride (GaN) and alloys within the GaN materials system such as AlGaN. Research activities range from basic research studies of materials and crystal growth to more applied investigations involving devices.

INSTRUMENTATION: The facility houses two state-of-the-art reactors for growth of GaN and its technologically important ternary compounds. Computer control of gas sequencing and delivery is being installed on one of these reactors. The remaining two reactors are reserved for gallium arsenide or indium phosphide growth and for growth of the technologically important ternary compounds of gallium arsenide. The laboratory has an integral safety system including gas detectors and alarms.

DESCRIPTION: The organometallic vapor phase epitaxy growth of homoepitaxial or heteroepitaxial films of GaN and AlGaN is performed on lattice matched and mismatched substrates such as platelets of bulk GaN, 6H-SiC, or sapphire. The growth is accomplished by the reaction of organometallic precursors that typically contain the column III metal, e.g., $Ga(CH_3)_3$ or $Al(CH_3)_3$, and the organometallic or hydride precursor of the column V element, e.g., NH_3. Depending on the semiconductor being grown, the reactions take place at pressures 5% to 50% of ambient over a substrate heated in the range of 500° to 1100 °C. Growth rates are typically determined by the column III precursor flux, which is controlled by the temperature and pressure of the sources and the mass flow rate of the high purity carrier gas flowing through the source, and range from 0.2 Å/s to 10 Å/s. The crystal quality is a direct function of growth parameters such as the pressure used for deposition. The epilayers can be doped n- or p-type with dopants such as Si or Mg. Through knowledge and control of the growth process, different types of structures containing complex heterojunctions can be grown. The equipment is housed in a specially designed and constructed building for the chemicals used in the growth process.

CONTACT:
Code 6860 • (202) 767-3671
LOCATION:
NRL, Washington, DC

Epicenter for Advanced Materials Growth and Characterization

The Epicenter

FUNCTION: Fabricates and analyzes heterostructures that are used in ongoing electronic and optoelectronic device efforts.

INSTRUMENTATION: This facility includes five interconnected ultrahigh vacuum systems for molecular beam epitaxy film growth and film analysis. Three of these chambers are used for molecular beam epitaxial growth of III-V semiconductors, II-VI semiconductors, and ferromagnetic semiconductors. Film analysis is accomplished with an angle-resolved electron spectrometer and a scanning tunneling microscope housed in the two other systems. These techniques provide information about the elemental composition, bonding configurations, and morphology of the film surfaces.

DESCRIPTION: Advances in molecular beam epitaxy allow the Epicenter to address the control of the structure of solids on the monolayer-length scale. This flexibility in the fabrication of semiconductors allows quantum mechanical control of electronic wave functions, which allows the electronic and optical properties of semiconductors to be engineered for particular device applications. Heterostructures formed from III-V semiconductors with 6.1 Å lattice spacing (GaSb, AlSb, InAs, and related alloys) are grown in the Epicenter. These heterostructures have the potential to define a new state of the art in applications that include >100-GHz high-speed logic circuits, terahertz transistors, sensitive infrared detectors, and mid-infrared semiconductor lasers. III-Mn-V ferromagnetic semiconductors and ZnMnSe, ZnCoSe, and ZnFeSe dilute magnetic semiconductors are also fabricated in the Epicenter. The development of these materials should allow the creation of a new class of devices with operating principles that rely on the spin of the electron, commonly referred to as "spintronics."

CONTACT:
Code 6870 • (202) 767-3693
LOCATION:
NRL, Washington, DC

Center for Biomolecular Science and Engineering

- Micro Fabrication Facility for Microfluidics
- Quadrupole Time-of-Flight Mass Spectrometer
- Advanced Microscopy Facility

Micro Fabrication Facility for Microfluidics

Haas CNC Minimill

Denkey HM-7 Injection Mold Machine

Potomac Photonics Laser Ablation System

FUNCTION: The milling and fabrication machines are being used to create micromixing and microfluidic components in glass and plastic for a wide variety of applications. It supports projects in the Chemistry Division, the Laboratory for Computational Physics, and the Center for Bio/Molecular Science and Engineering.

DESCRIPTION: The facility consists of a 7-ton Denkey HM-7 electric injection mold machine, a Haas CNC Minimill, a Techno-Isel CNC mill, a Potomac Photonics laser ablation system, and a KLA-Tencor P-15 Profilometer. The Haas Minimill has reproducibility and accuracy to 0.0002 in. The Laser Ablation System has a user-friendly software interface with vision and measurement capability. Designs can be imported from Autocad or other computer-aided design (CAD) software. Resolution is 0.25 μm and accuracy is 1-2 μm. Ablation depth can be less than 1 μm, depending on the material.

CONTACT:
Code 6910 • (202) 404-6027
LOCATION:
NRL, Washington, DC

Quadrupole Time-of-Flight Mass Spectrometer

API QSTAR® Pulsar i LC/MS/MS System

FUNCTION: The system generates superior quality mass spectrometry (MS) and tandem mass spectrometry (MS/MS) data from both atmospheric pressure ionization (API) and matrix-assisted laser desorption ionization (MALDI) techniques.

DESCRIPTION: The QSTAR®XL Hybrid LC/MS/MS System is a high-performance, hybrid quadrupole time-of-flight mass spectrometer designed for protein identification and characterization and drug metabolism studies. The unique flexibility to switch between the standard API, NanoSpray™ source, and the new oMALDI™ 2 ion source makes the QSTAR®XL System the preferred choice for proteomics. Specific scan modes such as precursor ion scanning, enabled by the patented LINAC™ Pulsar collision cell technology, identify the type and location of post-translational modifications or drug metabolites with outstanding specificity and sensitivity.

FEATURES:

- Enhanced ion optics for highest sensitivity and reliability
- Excellent mass accuracy and stability yield unequivocal molecular weight and high-quality structural information
- Unique, patented LINAC™ Pulsar collision cell technology enables the most sensitive product ion and precursor ion scan capabilities for metabolite, protein and peptide, and post-translational modification detemination
- Maximum flexibility with a comprehensive selection of interchangeable, application-specific ion sources: New oMALDI™ 2 source for increased sensitivity
- Sensitive and rugged IonSpray™, TurboIonSpray® and atmospheric pressure chemical ionization (APCI) ion sources — for routine low-level drug metabolism identification and characterization
- New NanoSpray™ ion source for capillary liquid chromatography (LC) provides increased sensitivity and throughput for protein and peptide identification and characterization
- New PhotoSpray™ source for analysis of low molecular weight, highly polar compounds via atmospheric pressure photoionization
- Extended MS and MS/MS mass range (6,000 and 40,000 m/z) expands scope of protein and peptide studies.

CONTACT:
Code 6910 • (202) 404-6043
LOCATION:
NRL, Washington, DC

Advanced Microscopy Facility

Advanced Microscopy Facility

FUNCTION: Provides a facility for high-resolution studies of complex biomolecular systems. The goal is an understanding of how to engineer biomolecules for various applications, including sensors, self-assembled lipid microstructures, patterned surfaces, and biomaterials.

DESCRIPTION: The facility includes electron microscopes, a darkroom, and adjacent biochemical laboratories for sample preparation and additional chemical/physical characterization of proteins, lipids, DNA, and cells.

INSTRUMENTATION:

- Digital scanning electron microscope - Leo 1455
- Hitachi H8100 analytical electron microscope (AEM)
- Zeiss transmission electron microscope (TEM) - EM10
- Scanning probe microscope - Topometric Explorer atomic force microscope (AFM)
- Digital Instruments AFM - Dimension 3100
- Scanning probe microscope capable of Multimode Atomic Force
- Microscopy and scanning tunneling microscopy (STM)
- Scanning-tip AFM capable of imaging large samples using contact mode, noncontact mode, lateral force mode, and force modulation mode
- TopoMetrix Aurora Near-field Scanning Optical Microscope (NSOM)
- Optical equipment
- Confocal fluorescent microscope
- Continuous wave (CW) fluorimeter and microscope
- Optical and fluorescence microscopes
- Freeze fracture apparatus - BALZERS BAF-400
- High-speed ultracentrifuges.

CONTACT:
Code 6930 • (202) 404-6018
LOCATION:
NRL, Washington, DC

OCEAN AND ATMOSPHERIC SCIENCE AND TECHNOLOGY DIRECTORATE

Code 7100 – Acoustics Division

Code 7200 – Remote Sensing Division

Code 7300 – Oceanography Division

Code 7400 – Marine Geosciences Division

Code 7500 – Marine Meteorology Division

Code 7600 – Space Science Division

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Acoustics Division

- Acoustic Communications Measurement Systems
- High-Frequency Acoustic Flow Visualization Systems
- Instrumentation Suite for Acoustic Propagation Measurements in Complex Shallow Water Environments
- Rail-based Broadband Synthetic Aperture Ocean Measurement System
- Structural Acoustics In-Air Facility
- Laboratory for Structural Acoustics
- Shallow Water Acoustic Laboratory
- Autonomous Acoustic Receiver System
- Salt Water Tank Facility
- Underwater Acoustic Time-Reversal Mirror
- Shallow-Water High-Frequency Measurement

Acoustic Communications Measurement Systems (ACOMMS)

ACDS Surface Unit being deployed from the research vessel *Endeavor*.

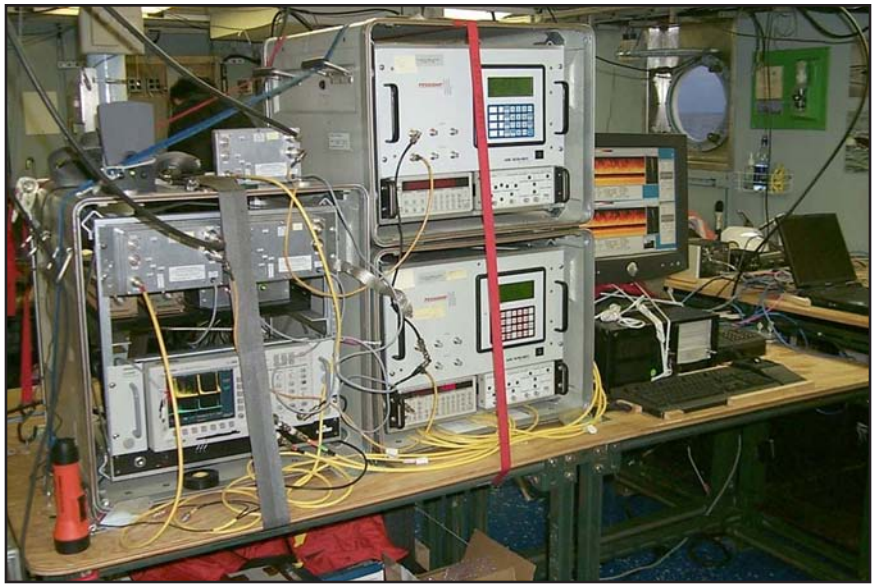
FUNCTION: Design and develop adaptive signal processing techniques to improve underwater acoustic communications and networking. Phase coherent and incoherent signal patterns are transmitted from NRL's acoustic projector source systems through the underwater medium to NRL's receiver systems. Improved signal processing techniques are developed and refined to minimize the bit error rate and to evaluate environmental influences on the processor's performance.

INSTRUMENTATION: (1) Acoustic Communications Data Storage (ACDS) buoy systems include three deployed modem systems, a shipboard control station, and wireless local-area network (WLAN) communication links. Each deployed modem system includes one acoustic projector (3, 10, or 20 kHz), eight hydrophones, 300 GB of data storage, and three computers. The systems can be moored to the ocean bottom or towed behind a surface vessel. (2) Towed source systems include 3- and 4-ft V-fin towbodies mounted with acoustic projectors, driven by 2-kW power amplifiers. (3) Shipboard-based receiver system includes a custom 16-channel hydrophone array, signal processing electronics, data monitoring and data recording equipment.

DESCRIPTION: Our acoustic communications research systems enable our team to conduct experiments at frequencies from 3 to 60 kHz. Source signal patterns are designed by NRL, transmitted into the ocean medium, and received at distances out to 15 km. The received signals are processed in situ and recorded for post-experiment data processing. ACDS buoy systems transmit at source levels up to 185 dB. For higher sound pressure levels, an acoustic projector mounted in our 4-ft V-fin towbody develops up to 200 dB. ACDS buoy systems include eight-element vertical line arrays with variable apertures. Our shipboard-based vertical array has a wide aperture of 16 elements and is deployed from a vessel at anchor. Relative position, speed, and depth of our projectors and receiver arrays are carefully controlled throughout the experiments. Impact of Doppler and signal-to-noise ratio on system performance is measured and algorithms developed to improve performance. Our ACDS systems are normally moored to the sea floor with the acoustic elements suspended in the water column. However, one ACDS system has been modified for attachment to a tow frame, and in this configuration it provides a near-ideal autonomous undersea vehicle (AUV) test platform. Each of the ACDS systems provide semi-autonomous operations for up to 78 hours. Custom-designed software is used for onboard data monitoring and signal processing. Back in the lab, advanced signal processing algorithms are applied to the recorded signals to extract the phase-encoded bit patterns and to improve communication accuracy.

CONTACT:
Code 7120 • (202) 767-2945
LOCATION:
NRL, Washington, DC

High-Frequency Acoustic Flow Visualization (HFAFV) Sonar Systems



HFAFV systems on board the research vessel *Endeavor*, in the Atlantic Ocean off the coast of New Jersey.

FUNCTION: Flow visualization of fluid processes on the continental shelf; e.g., internal tides, shear instabilities, and nonlinear internal gravity waves (solitons).

INSTRUMENTATION: Two similar systems, differing only in operating frequency:

(1) Matec PR5000 gated sine wave pulse generator and power amplifier, NRL-developed transmit-receive switch, custom-designed transducer (200 kHz)

(2) Matec PR5000 gated sine wave pulse generator and power amplifier, NRL-developed transmit-receive switch, custom-designed transducer (350 kHz)

(3) Personal computer-based data acquisition system, using off-the-shelf analog-to-digital converters and ISIS software from Triton Elics.

DESCRIPTION: Our HFAFV sonar systems are used to image the fluid processes that perturb the density/sound speed field in the littoral. A patented high-speed transmit-receive switch provides NRL with the receive sensitivity necessary to detect the small amplitude signals backscattered from particulates and temperature/salinity variability associated with large density gradients in the thermocline. At the laboratory, the data is processed and analyzed with the objective of improving our understanding of the generation and propagation of internal waves and fine structure and their effect on the sound speed field.

CONTACT:
Code 7120 • (202) 767-2945
LOCATION:
NRL, Washington, DC

Instrumentation Suite for Acoustic Propagation Measurements in Complex Shallow Water Environments

Deployment of instrumentation sled for 96-element Acoustic Horizontal Line Array Receiver System.

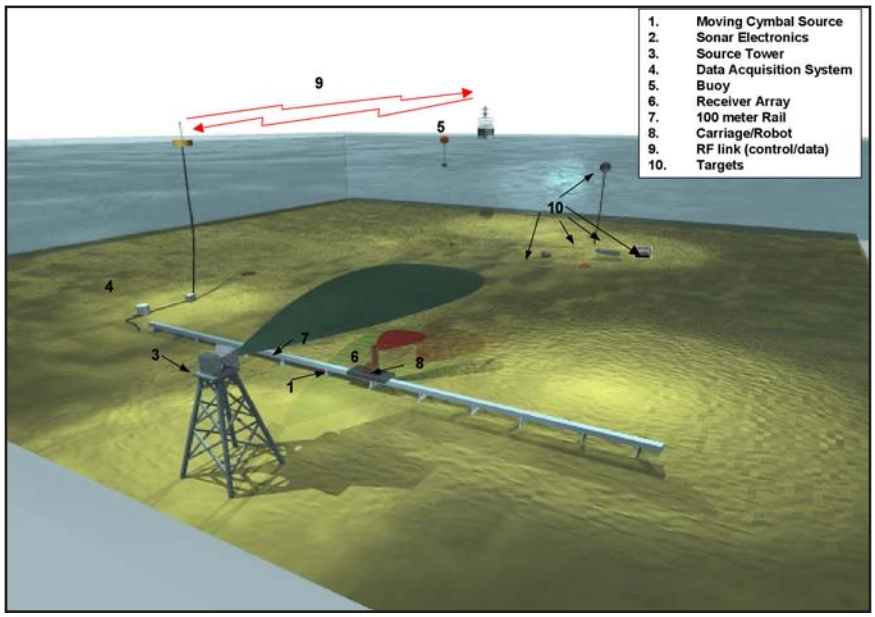
FUNCTION: Obtain at-sea measurements to test theoretical and modeling predictions of acoustic propagation in dynamic, inhomogeneous, and nonisotropic shallow-water environments. The theories and models predict variations of signal amplitude, coherence, and travel time due to interaction of sound with small- to large-scale volume inhomogeneities within the water column and ocean sediment. The instrumentation suite provides calibrated measurements of these acoustic quantities in the frequency range 50 Hz to 20 kHz.

INSTRUMENTATION: The instrumentation suite consists of several acoustic sources and receiver array systems, augmented by sensors to characterize the oceanographic environment. The current equipment suite is composed of two autonomous arbitrary waveform acoustic sources, two autonomous continuous wave (CW) acoustic sources, three autonomous 32-element acoustic Vertical Line Array Receiver Systems, one autonomous 96-element acoustic Horizontal Line Array Receiver System, and one 32-element RF Telemetered acoustic Vertical Line Array Receiver System.

DESCRIPTION: The multiple sources and receivers in this instrumentation suite allow measurement of acoustic propagation variability as a function of both time and range over horizontal and vertical apertures. The autonomous systems can operate in severe weather conditions since they have no sea-surface expression, while the RF Telemetered Receiver System can provide real-time information on acoustic propagation. The acoustic receiver systems each have an operational lifetime up to 20 days at a sampling frequency of 4 kHz. The operational lifetime for each acoustic source is ~25 days at a 50% duty cycle. Clocks having rubidium-standard accuracy control all timing functions for the acoustic sources and receivers, including waveform synthesis and sampling of the received signals. This feature permits measurement of absolute travel time and its variations to better than millisecond accuracy and allows data from each of the autonomous receiver systems to be time-synced together for phase-coherent processing.

CONTACT:
Code 7120 • (202) 767-2493
LOCATION:
Chesapeake Bay Detachment • Chesapeake Beach, MD

Rail-Based Broadband Synthetic Aperture Ocean Measurement System



A depiction of the 100-m-long rail deployed in shallow water together with the source tower, data acquisition system, RF link to surface vessel, and scattering targets.

FUNCTION: Enables collection of broadband acoustic scattering databases where acoustic sources and receivers can be translated on a precise linear path under program control. Further, the phasing of the source and data acquisition is highly coherent such that scattering data can be processed to form synthetic apertures. This facility supports research in the collection of high-quality scattering cross sections of mines and the associated clutter, with the intent of perfecting techniques required for unmanned undersea vehicles (UUVs).

DESCRIPTION: The facility is a portable measurement system that can be deployed in an ocean environment. The primary elements are a 100-m-long rail that supports a robotic carriage that can be positioned precisely at any point along the rail using an encoder feedback system. The sources and receivers can be attached to the carriage to collect quasi-monostatic data, and a separate source tower enables bistatic scattering data collection. All data acquisition, process control, and signal conditioning are contained within a pressure vessel that sits on the sea floor adjacent to the rail. Bidirectional control and data transfers are made over a dedicated RF link to a surface platform.

CONTACT:
Code 7136 • (202) 404-3840
LOCATION:
Ocean deployed

Structural Acoustics In-Air Facility

Structural Acoustics In-Air Facility

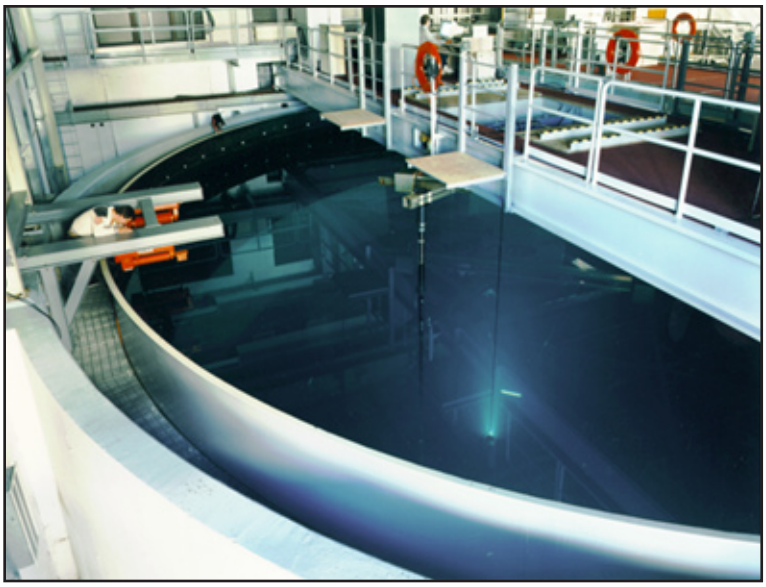
FUNCTION: Supports experimental research where broadband acoustic radiation, reflection, transmission, and surface vibration measurements are required. Typically, ultrahigh-precision, highly spatially sampled measurements are conducted on scaled submarine structures, satellite payload fairings, active and passive material systems for sound control, and new transducer and sensor systems.

INSTRUMENTATION: Broadband source/receiver systems; large workspace (3-D) robotic scanners for near-field acoustic holography (NAH); scanning laser Doppler vibrometry (LDV); multiple workstations to support acquisition, analysis, calculations, and visualization; and structural acoustic codes: SARA2D, SARA3D, ANSYS, NISA, FEMLAB, and SONAX.

DESCRIPTION: The large, acoustically treated facility is 50 ft × 40 ft and 38 ft high. The laboratory is instrumented with precise acoustic and vibration measurement systems. These include large workspace robotic scanners capable of generating NAH radiation, reflection, and transmission databases. In addition, three-axis laser vibrometers are used to generate very highly sampled surface vibration maps.

CONTACT:
Code 7136 • (202) 404-3840
LOCATION:
NRL, Washington, DC

Laboratory for Structural Acoustics



Laboratory for Structural Acoustics

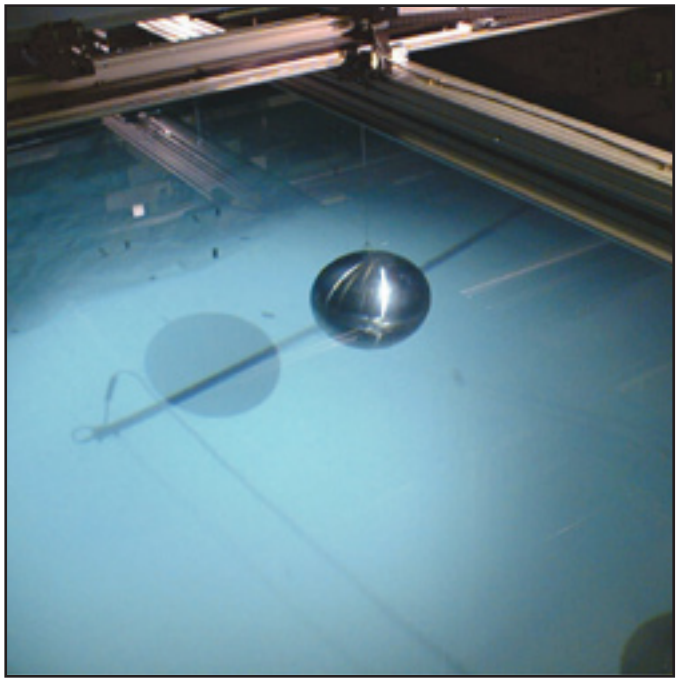
FUNCTION: Supports experimental research where acoustic radiation, scattering, and surface vibration measurements of fluid-loaded and nonfluid-loaded structures are required. Typically, ultrahigh-precision measurements are conducted in this pristine laboratory environment using submarine hull backing impedance simulators, torpedoes, scale-model submarine structures, and deactivated mine targets.

INSTRUMENTATION: Network-based automated data acquisition and process control including extensive use of robotic scanners. Other attributes and resources include: compact measurement ranges using near-field sources and receivers; multiaxis Doppler vibrometers for noncontact surface motion measurements; extensive interferometric fiber-optic sensor instrumentation; matrix processors that support MIMO control applications using state space finite impulse response (FIR), infinite impulse response (IIR), or adaptive controllers; multiple workstations and file servers to support acquisition, structural acoustics calculations, and visualizations; and structural acoustics codes: SARA2D, SARA3D, ANSYS, NISA, FEMLAB, and SONAX.

DESCRIPTION: The large acoustic tank—the core research capability for in-water structural acoustics studies—is 55 ft in diameter, 50 ft deep, and contains 800,000 gal of deionized water. The entire tank is vibration and temperature isolated. The laboratory is instrumented with precision measurement systems that include large workspace in-water robotic scanners capable of generating near-field acoustic holography (NAH) radiation and scattering databases.

CONTACT:
Code 7136 • (202) 404-3840
LOCATION:
NRL, Washington, DC

Shallow Water Acoustic Laboratory



Shallow Water Acoustic Laboratory

FUNCTION: Supports experimental research where high-frequency acoustic scattering and surface vibration measurements of fluid-loaded and nonfluid-loaded structures are required. Typically, ultra-high-precision measurements are conducted in this pristine laboratory environment when acoustic interactions with sediments are important.

INSTRUMENTATION: Network-based automated data acquisition and process control including extensive use of robotic scanners. Other attributes and resources include: broadband source/receiver systems; compact measurement ranges using near-field sources, receivers, and projection algorithms; multiaxis Doppler vibrometers for noncontact surface motion measurements of porous media water interfaces; multiple workstations to support acquisition analysis, calculations, and visualizations; structural acoustics codes: SARA2D, SARA3D, ANSYS, NISA, FEMLAB, and SONAX.

DESCRIPTION: This facility includes a large concrete pool (250,000 gal of deionized water) equipped with high-resolution, computer-controlled target source and receiver manipulators. It is used for high-frequency acoustic scattering characterization of scale-model submarines and deactivated mine targets. The pool's bottom has a deep, sandy bottom and a high-resolution Cartesian near-field acoustic holography (NAH) scanner to accommodate the controlled acoustic study of buried and near-buried mines.

CONTACT:
Code 7136 • (202) 404-3840
LOCATION:
NRL, Washington, DC

Autonomous Acoustic Receiver (AAR) System

Surface telemetry buoy connected to a 64-element acoustic receiver.

FUNCTION: Collects underwater acoustic data and oceanographic data. Data are recorded onboard an ocean buoy and can be telemetered to a remote ship or shore station in real time. The system is configured for command-and-control and data download. It can operate unattended for periods of up to one month.

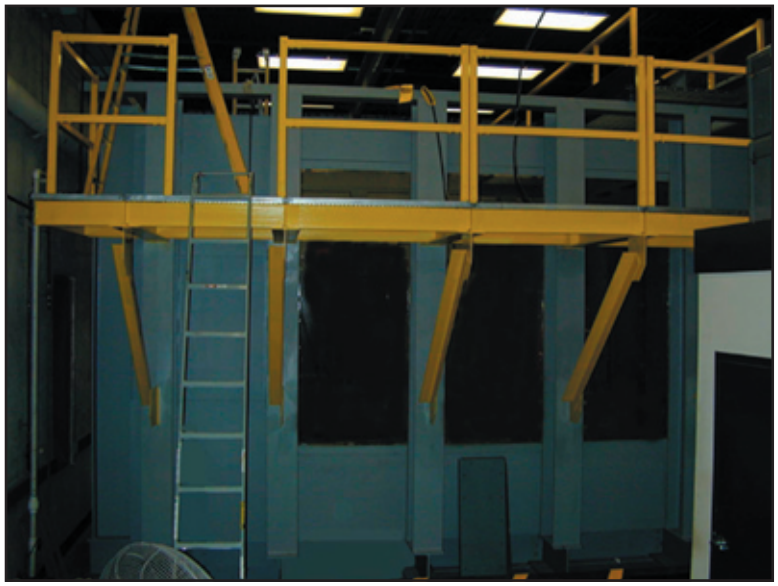
DESCRIPTION: The heart of the system is the data acquisition unit (DAU) containing the analog-to-digital converters for 64 channels at rates up to 8192 samples per second. One 64-element or two 32-element acoustic receive arrays can be attached to this DAU. If used vertically, there is also capability to add four tilt/head/depth sensors spaced throughout the vertical array. Once digitized, the data are sent up a 2000-ft fiber-optic umbilical cable to a surface buoy, where they are stored on hard disk. The data can then be telemetered to another location. The line-of-sight link can also be used to send command-and-control information to the system.

INSTRUMENTATION:

- 16-bit, 8192 samples per second, 64-channel DAU
- 64-element, 1.25-m spacing acoustic receive array
- 32-element, 2.5-m spacing acoustic receive array
- 32-element, 5-m spacing acoustic receive array
- 2000-ft fiber-optic double-armored umbilical cable
- Battery-powered buoy with enhanced line-of-sigh capability
- Command-and-control/data downlink station with GPS-linked steerable, directional antenna (for remote ship or shore station).

CONTACT:
Code 7145 • (202) 404-4826
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Salt Water Tank Facility



The main salt water tank provides excellent optical access to the controlled saline environment.

FUNCTION: Provides a controlled environment for studying complex bubble-related processes found in the ocean. It is an experimental pool facility for studies of underwater acoustics, fluid dynamics, and air-sea interface environmental topics, under saline conditions. This facility is currently being used to study the acoustics of bubbly media.

INSTRUMENTATION:

- Acoustic sources, amplifiers, and hydrophones spanning 1 Hz to 700 kHz
- Environmental sensors to measure water temperature, salinity, dissolved gas concentrations, and surface tension
- Digital holographic imaging system to size particles down to ~5 μm
- Two high-speed digital cameras providing image acquisition up to 2000 full frames per second
- LabVIEW-based data acquisition system with laboratory-wide network access
- Brickwall filters, digital and analog oscilloscopes, data loggers, and power supplies.

DESCRIPTION: The main salt water tank measures 20 × 20 ft square × 12 ft high, with four 12 × 8 ft windows on each of the vertical walls. The water is recirculated every 10 h through particulate and UV filters, and the tank contains a high-capacity water chiller for controlling temperature. A separate chiller independently handles the air temperature. Catwalks and a gantry provide access around and over the main tank, and a three-axis computer-controlled positioning system with four independent stages places and moves equipment within the tank. The tank is contained within a thermally insulated 50 × 26-ft laboratory area furnished with an overhead crane, a staging area, and a 20 × 10-ft room for instrumentation and data analysis.

CONTACT:
Code 7145 • (202) 404-4826
LOCATION:
NRL, Washington, DC

Underwater Acoustic Time-Reversal Mirror

Preparing 64-element source/receive array for deployment

FUNCTION: Records underwater acoustic signals and has the capability to time-reverse and re-broadcast these signals. This provides the ability to focus and scan acoustic energy for the detection of underwater objects. The signals could be emitted from guide sources or received in the form of ocean reverberation.

INSTRUMENTATION: (1) 64 - 6 in. spherical source/receive elements in a linear array with 1.25-m spacing (78.75-m aperture); (2) Array elements are independently controllable over 500 to 3500-Hz frequency band; (3) A data digitization and recording system; (4) A pressure vessel to enclose system electronics for bottom-moored deployment; (5) Fiber-optic umbilical cable for connection between pressure vessel and ship/surface buoy.

DESCRIPTION: The heart of the system is a 64-element transducer array that can alternately operate as a receiver array or an array of acoustic sources. The time-reversal functionality involves the capability to record signals, reverse them in time, and then re-broadcast them. This provides, for example, the capability to have a received signal returned to its point of origin where it will focus in both time and space. The importance of the concept is that this can be accomplished without detailed knowledge of the complex multipath structure produced by the ocean waveguide. Applications include enhanced echos from target objects, such as submarines or ocean mines, and reduced clutter echos from the ocean bottom or ocean surface.

CONTACT:
Code 7145 • (202) 404-4820
LOCATION:
Chesapeake Bay Detachment • NRL, Chesapeake Beach, MD

Shallow-Water High-Frequency Measurement Systems

Shallow-Water High-Frequency Measurement Systems

FUNCTION: Supports a broad range of shallow-water high-frequency research programs. Those objectives range from acquiring a fundamental understanding of the physics of shallow-water propagation and boundary interactions to applied mine countermeasure and torpedo issues. The development of these systems has made NRL a leader in high-frequency shallow-water environmental acoustics research. Scattering and propagation measurements have been conducted in areas that range from the Gulf of Mexico to the Mediterranean. The data have been used in synthetic aperture sonar and torpedo simulations and design.

INSTRUMENTATION: These systems include high-resolution source and receiver combinations that operate in the shallow to very-shallow-water (7 to 30 m) coastal areas.

DESCRIPTION: These systems cover the 18 to 200-kHz frequency range. System control and data acquisition are carried by fiber-optic cables that terminate in a portable instrumentation van where the data are digitized and recorded on optical disks.

CONTACT:
Code 7184 • (228) 688-5235
LOCATION:
NRL, Stennis Space Center, MS

Remote Sensing Division

- Naval Prototype Optical Interferometer
- Optical Spectral Measurements Facility
- Free Surface Hydrodynamics Laboratory

Naval Prototype Optical Interferometer (NPOI)

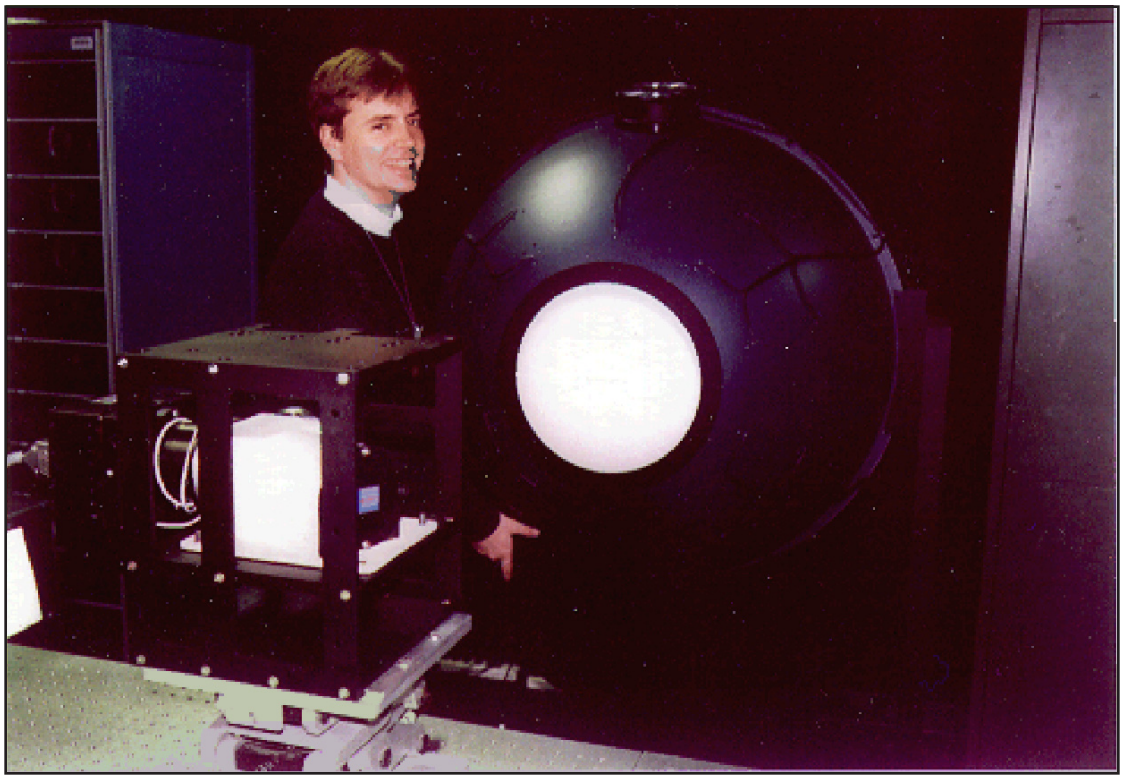
The NPOI, located on Anderson Mesa near Flagstaff, AZ,
is the largest operating optical telescope in the world

FUNCTION: Used for astrometry and astronomical imaging, the NPOI is a distributed aperture optical telescope. It is operated for astrometry by the U.S. Naval Observatory. Research into optical imaging and astronomical research is conducted by NRL.

DESCRIPTION: The NPOI is a Y configuration of optical sidereostats. The inner fixed stations are used for astrometry while stations on the outer arms, out to an eventual separation of more than 300 m, are used for imaging stars. The stations are connected by vacuum beamlines. Fast delay lines in the main control building and long delay lines outside are used to adjust the optical phases to allow coherent combinations of up to six sidereostats.

CONTACT:
Code 7210 • (202) 767-0669
LOCATION:
NRL, Washington, DC

Optical Spectral Measurements Facility



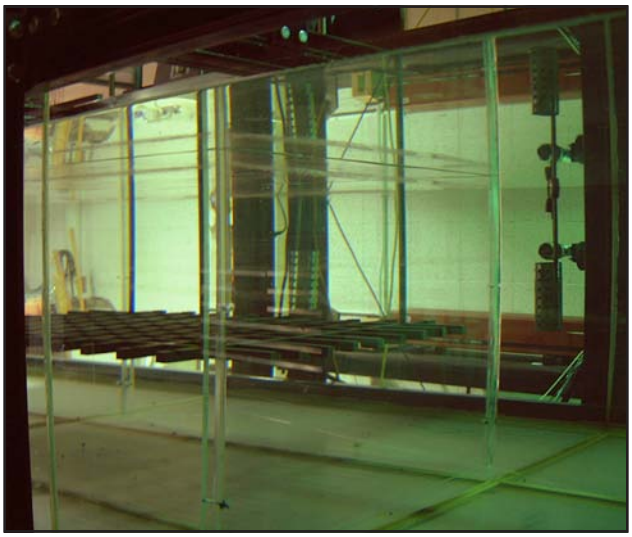
Large black-body calibration sphere

FUNCTION: Establishes and maintains procedures for calibrating in-water radiometers and hyperspectral imagers. Such calibration is needed for both research use of the sensors and to maintain traceability to National Institute of Standards and Technology (NIST) calibration devices and standards.

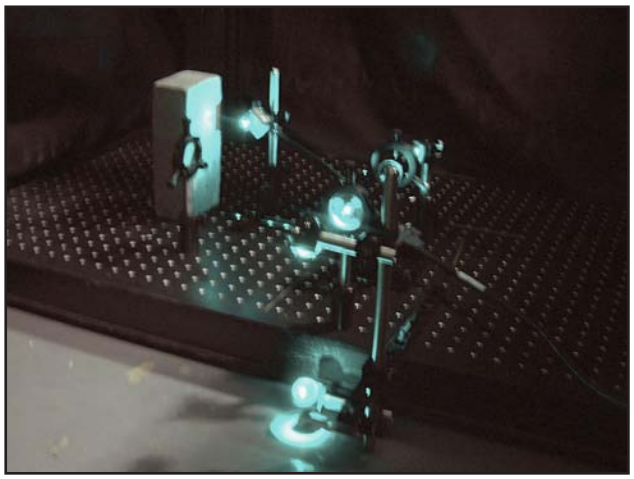
DESCRIPTION: The facility consists of a precise optical bench with spectrometers, calibration lamps, and black-body calibration spheres required to establish wavelength and intensity calibration of optical and near-infrared sensors. All components are cross-calibrated to a NIST Standard FEL lamp using a stable reference detector. Calibration procedures meet or exceed NIST and NASA requirements. The laboratory is an official SeaWiFS calibration facility, and participates in NASA "round-robin" calibrations. It has been used to calibrate all three versions of the PHILLS hyperspectral instruments: Slow Scan Spectrometer, HYCORDER, and Ocean PHILLS. It will be used to calibrate the Coastal Ocean Imaging Spectrometer (COIS) instrument, which is proposed to fly on the NPOESS Charley II mission.

CONTACT:
Code 7230 • (202) 404-2475
LOCATION:
NRL, Washington, DC

Free Surface Hydrodynamics Laboratory



Tank facility with the grid turbulence generator installed



Optics, located under the tank, that illuminate the flow

FUNCTION: Investigates processes and interactions at the ocean's surface and compares measurements to numerical calculations. Typical investigations include the development of small capillary waves, heat and momentum flux through the surface, and signatures of turbulent flow.

INSTRUMENTATION: Two high-sensitivity infrared cameras, a high-speed video camera, the Particle Imaging Velocimetry System, and a Langmuir Trough.

DESCRIPTION: The laboratory contains a number of instrumented tanks including a large 10 × 10 × 5-ft tank with a grid turbulence excitation facility.

CONTACT:
Code 7253 • (202) 767-2457
LOCATION:
NRL, Washington, DC

Oceanography Division

- Ocean Sciences and Remote Sensing Research Facility
- Environmental Microscopy Facility
- Ocean Dynamics and Prediction Network
- Ocean Color Facility
- Littoral Current Measurement Facility
- Scanning Slope Sensing and Wave Gauge Array Buoy
- Salinity Temperature and Roughness Remote Scanner
- Field Staging Facility
- Ocean Optics Instrumentation Systems

Ocean Sciences and Remote Sensing Research Facility

Ocean Sciences and Remote Sensing Research Facility

FUNCTION: A 52,000–ft^2 state-of-the-art building specifically designed to house NRL's Oceanography Division of the Ocean and Atmospheric Science and Technology Directorate. The Oceanography Division consists of two branches; (1) Ocean Dynamics and Prediction and (2) Ocean Sciences. The division's mission is to: (1) develop oceanographic models of the ocean and littoral areas for operational use, (2) investigate and describe the physical processes that couple and control the ocean and, (3) develop capabilities to use remote-sensed data to describe and measure the oceanographic process of the open ocean and its littoral areas.

INSTRUMENTATION: Specifically, the building contains; (1) an environmental scanning electron microscope with an energy dispersive X-ray detector, (2) an advanced seagoing instrumentation and calibration lab, (3) a Secure Data Processing Laboratory, (4) a workstation network with more than 20 terabytes of Fibre-Channel and SCSI disk storage. In addition, the building's roof features Sea-viewing Wide Field-of-view Sensor (SeaWiFS) for ocean color and National Oceanic and Atmospheric Administration (NOAA) polar orbiting receivers.

DESCRIPTION: The building was designed to perform research for ocean processes. The laboratories, office spaces, and conference rooms in the building are specially wired for high-speed computer networking within the building and to the DoD High-Performance Computing (HPC) national network. The remote sensing laboratories also have direct access to selected satellite data streams.

CONTACT:
Code 7300 • (228) 688-4670
LOCATION:
NRL, Stennis Space Center, MS

Environmental Microscopy Facility

Environmental Microscopy Facility

FUNCTION: Provides high-resolution (5-nm) images and elemental composition (elements heavier than sodium) of hydrated specimens, including biological materials. The facility is essential for demonstrating spatial relationships between microorganisms and substrata and for investigating biofouling, bioremediation, and biodeterioration.

INSTRUMENTATION:

- Environmental scanning electron microscope (ESEM) equipped with an energy-dispersive X-ray detector and an image acquisition and archive system
- Laser confocal scanning microscope.

DESCRIPTION: The Environmental Microscopy Facility is equipped to examine the spatial distribution of microorganisms in biofilms and their impact on microbiologically influenced corrosion, biomineralization, and bioaccumulation. The ESEM with a differential pumping system permits a 2-D examination of viable cells and a precise mapping of associated elements. The ESEM has been used to determine failure mechanisms for welded stainless steels, fiber-reinforced polymers, coatings, sealants, and emulsifiers. The laser confocal scanning microscope provides a 3-D examination of microbial substrata relationships.

CONTACT:
Code 7303 • (228) 688-5494
LOCATION:
NRL, Stennis Space Center, MS

Ocean Dynamics and Prediction Network

Central elements of the Sun and Alpha workstation clusters, and DLT tape library

FUNCTION: Provides general-purpose computer services to branch personnel for program development, graphics, data processing, storage, and backup. Provides network connectivity to other Navy sites, to the DoD High-Performance Computing centers, and to the Internet.

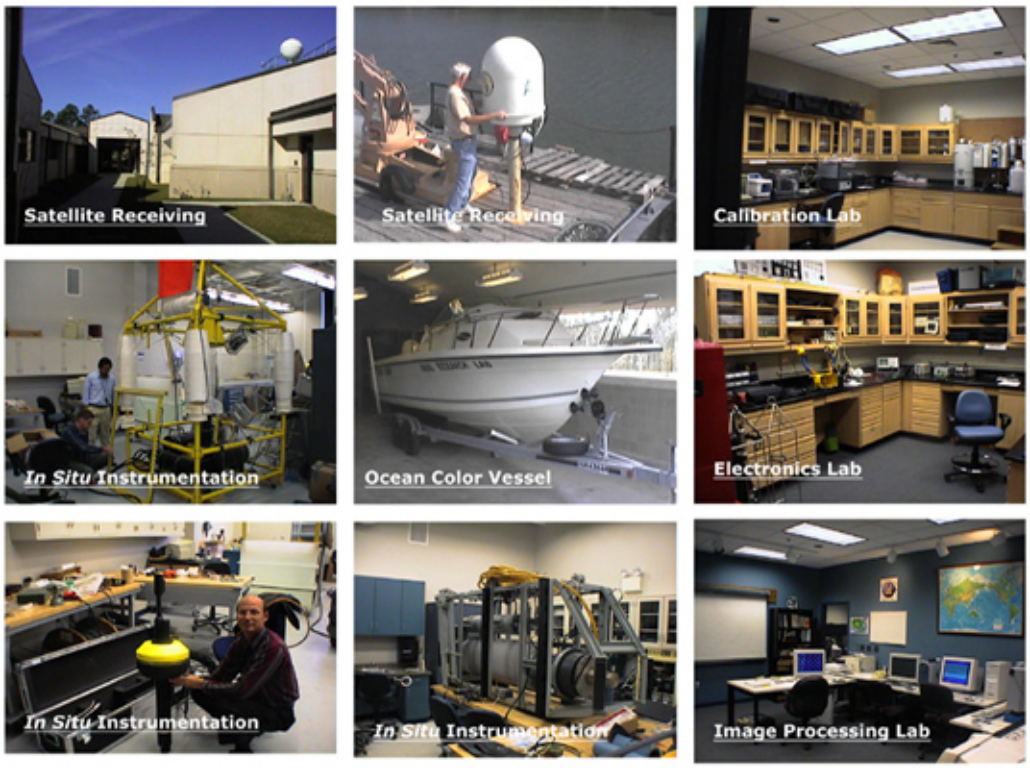
INSTRUMENTATION:

- AMD Opteron workstations, Sun UltraSPARC, Dell Xeon, and Alpha compute and fileservers
- Quantum ATL four-drive SuperDLT tape library
- 60 terabytes (TB) of centralized disk storage.

DESCRIPTION: The workstation network includes 60 UltraSPARC workstations and servers, 12 Alpha computer servers, 35 dual-CPU Opteron workstations, over 50 Intel Xeon systems running Linux, plus all connected peripherals and the connecting network. Over 60 terabytes of Fibre-Channel and SCSI disks provide storage. Systems are linked by 100 Mbps and gigabit Ethernet. Central disk storage is on a Veritas high-availability cluster. UltraSPARC and Linux/Intel workstations are configured in a Grid Engine cluster. The network is backed up using a four-drive SuperDLT tape library. Operating systems in use include Sun's Solaris, Linux, and Windows.

CONTACT:
Code 7320 • (228) 688-4895
LOCATION:
NRL, Stennis Space Center, MS

Ocean Color Facility



Ocean Color Facility

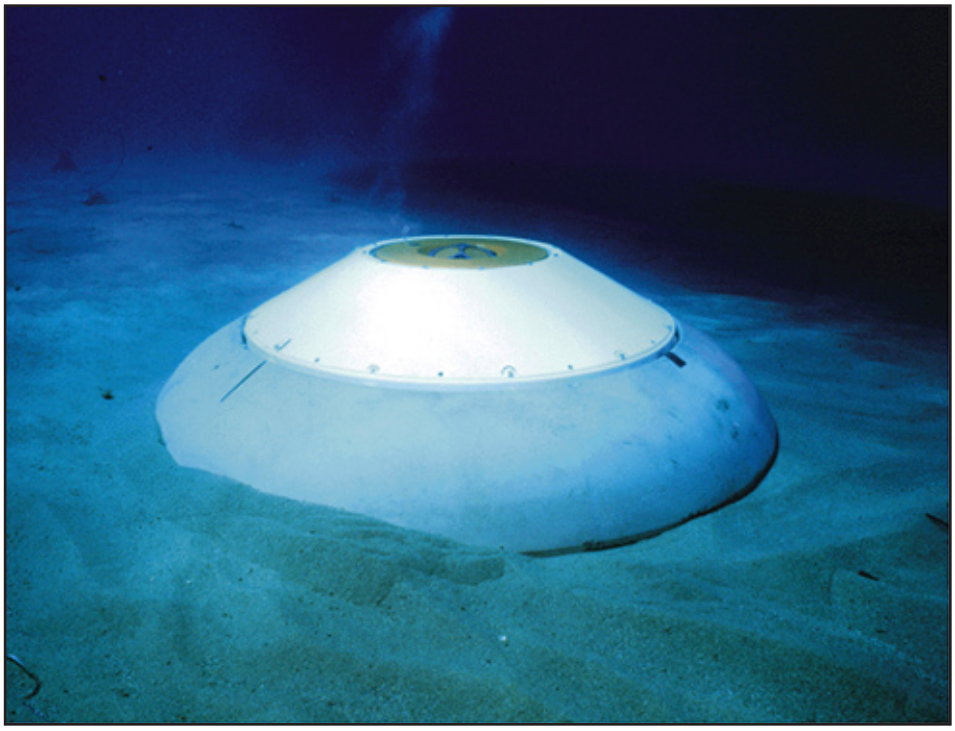
FUNCTION: Maintains a state-of-the-art image processing, instrumentation, and satellite receiving capability. The laboratory is developing advanced algorithms for space and aircraft ocean color sensors (SeaWiFS, MODIS, MOS, AVIRIS, PHILLS, HYDICE).

INSTRUMENTATION: The laboratory has both fixed and shipboard antenna systems to support global experiments. It maintains a host of over 30 workstations and an archive of 700 GB of ocean color imagery. The laboratory also maintains an advanced at-sea instrumentation and calibration laboratory specializing in coastal ocean color. Facilities include spectral absorption, scattering and reflectance measurements, and laboratory spectrometers.

DESCRIPTION: The laboratory is currently a SeaWiFS NASA receive site for real-time data capture and processing of ocean color imagery. Real-time ocean color products are used for ship sample collection experiments. The laboratory processes more than 4 GB of imagery daily, coming from collection systems all over the world. These data are used for the development, tuning, and validation of advanced algorithms relating spectral signatures to ocean properties and processes.

CONTACT:
Code 7330 • (228) 688-5268
LOCATION:
NRL, Stennis Space Center, MS

Littoral Current Measurement Facility



Barny trawler-resistant, ADCP bottom mount deployed on the sea floor

FUNCTION: Measures ocean current measurements throughout most of the world's shallow seas and shelves. Twelve units are available for positioning on the sea floor where they measure ocean currents and sea-surface height. The units contain internal recording instruments and may be left in place for periods of up to several months.

INSTRUMENTATION: Barnys host the following instruments, which are part of the facility:

- One Acoustic Doppler Current Profiler (ADCP)—RD Instruments, Sentinel model 300, 600, or 1200 kHz, some capable of measuring surface wave spectra as well as currents
- One wave-tide gauge—Sea-Bird model 026
- Two acoustic releases—EdgeTech model 8202 or AMTR200.

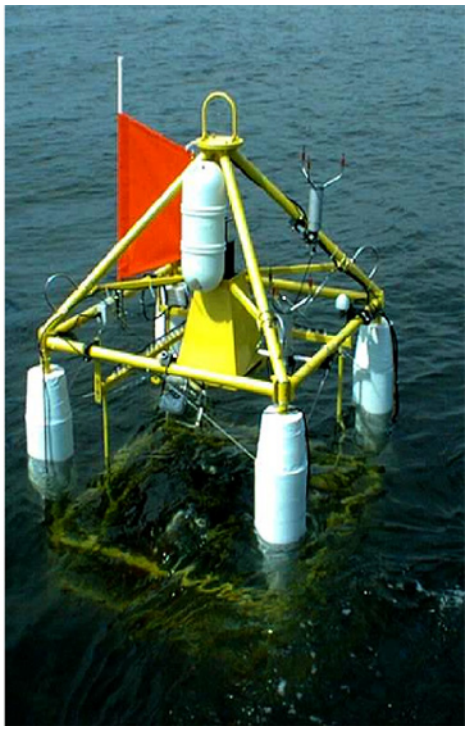
DESCRIPTION: Each unit, called a Barny because of its barnacle-like shape, consists of three major components: a circular outer cement ring for ballast and impact protection, a buoyant main instrument housing, and a pop-up float. An onboard ADCP measures currents throughout the water column by an acoustic Doppler backscatter technique. The centrally located pop-up float surfaces on acoustic command, bringing with it a line for recovering the rest of the unit. The unit's overall low, smooth shape—a feature critical for instrument survival in coastal waters—makes it very unlikely to be affected by fishing trawlers. Barnys were developed through a Cooperative Agreement between NRL and NURC Research Centre in Italy.

CONTACT:
Code 7332 • (228) 688-5251
LOCATION:
NRL, Stennis Space Center, MS

Scanning Slope Sensing and Wave Gauge Array Buoy (SSSWGAB)

The Scanning Slope Sensing and Wave Gauge Array Buoy

(a) Readying for deployment into the ocean



(b) In free-drifting operation

FUNCTION: Acquires in situ spatial properties of water waves. These wavelengths range from 4 mm to 1 m and cover the band of surface waves contributing to the ocean surface roughness responsible for air-sea transfers and ocean remote sensing.

INSTRUMENTATION: In addition to the wave sensors, the buoy carries a suite of environmental sensors: above surface—two sonic anemometers, thermometer, humidity sensor, video recorder; subsurface—acoustic current meter, thermometer, two pressure sensors, two accelerometers, video recorder.

DESCRIPTION: Short ocean waves are the primary contributors to ocean surface roughness, which is of critical importance to the interpretation of ocean features from remote sensing and to the understanding of air-sea interaction processes driving the ocean circulation and water wave evolution. The system is designed to measure the directional spectrum of short surface waves. The resolved spectral band, 0.004 to 1 m, is of extreme importance to the determination of ocean surface roughness related to air-sea interaction and ocean remote sensing. Two different measurement techniques are used: optical scanning slope sensing for shorter waves (0.4 to 10 cm), and displacement sensing using a thin-wire gauge array for longer waves (10 cm to 1 m). The sensor modules are carried on a wave-following platform. To reduce flow disturbance from the sensor platform, the system operates in free-drift mode.

CONTACT:
Code 7332 • (228) 688-4708
LOCATION:
NRL, Stennis Space Center, MS

Salinity Temperature and Roughness Remote Scanner (STARRS)

The STARRS system is flown beneath the fuselage on a variety of aircraft

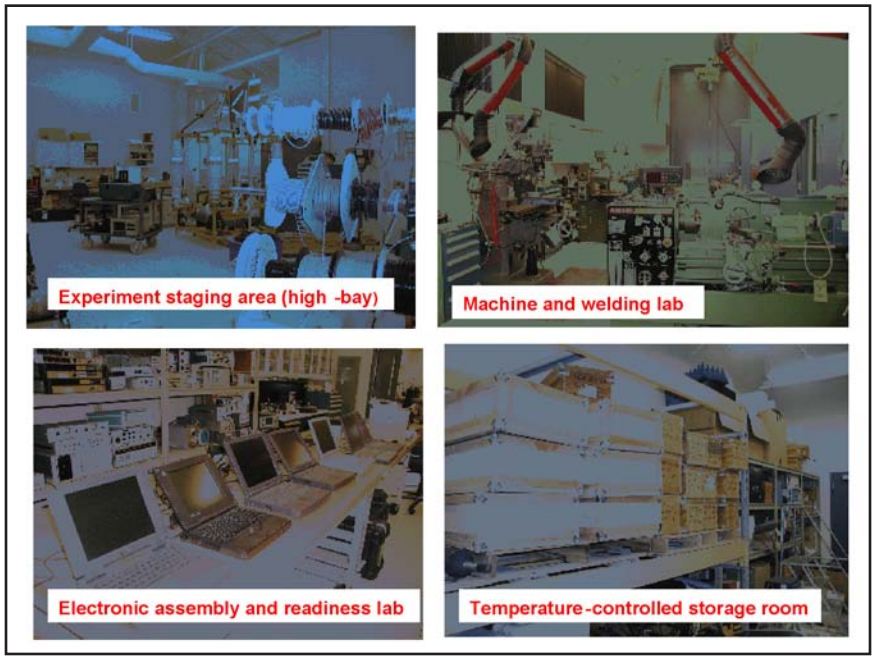
FUNCTION: Provides spatially continuous high-resolution surface salinity imagery in a synoptic manner from small aircraft. Its output complements data collected from ship-based and moored systems, puts those data sets into synoptic context, and provides key information for assimilation into predictive models of physical fields including currents, temperature, salinity, and sound speed in the littoral and open oceans.

INSTRUMENTATION: (1) A multibeam 1.4-GHz L-band radiometer based on a low-noise microstrip patch antenna for the primary salinity/brightness/temperature measurement. (2) A two-channel split-window infrared radiometer for sea surface temperature. (3) A single-beam multichannel C-band radiometer for estimates of sea surface roughness. The secondary subsystems (2) and (3) provide useful oceanographic information in their own right in addition to being key parameters in the retrieval of salinity from the primary subsystem (1).

DESCRIPTION: STARRS is an imaging sensor that provides complete areal coverage of surface salinity in a swath twice as wide as the aircraft's altitude. The swath is resolved into several adjacent cells, and swaths can be quickly flown adjacent to each other. STARRS includes advanced primary and secondary measurement components to assure salinity retrieval with total noise levels less than a few tenths of one primary sample unit (psu) under a wide range of environmental conditions. The most persistent force driving currents in the littoral is due to density differentials between water masses. These are caused by the flux of low salinity waters from bays and rivers to the coastal zone as well as the contrasts between shelf and open-ocean waters. Similar contrasts drive large-scale open-ocean currents. STARRS' capabilities allow researchers to routinely obtain high-resolution imagery in a synoptic fashion.

CONTACT:
Code 7332 • (228) 688-5487
LOCATION:
NRL, Stennis Space Center, MS

Field Staging Facility



Field Staging Facility

FUNCTION: Facilitates routine maintenances for NRL seagoing measurement systems: ocean current (BARNY, SEPTR); air-borne salinity (STARR); and air-sea interaction (WGA/SSS). This facility is equipped with high-precision machinery, calibration chambers, and electronic equipment to adjust, repair, and assemble mechanical and electronic components of the systems.

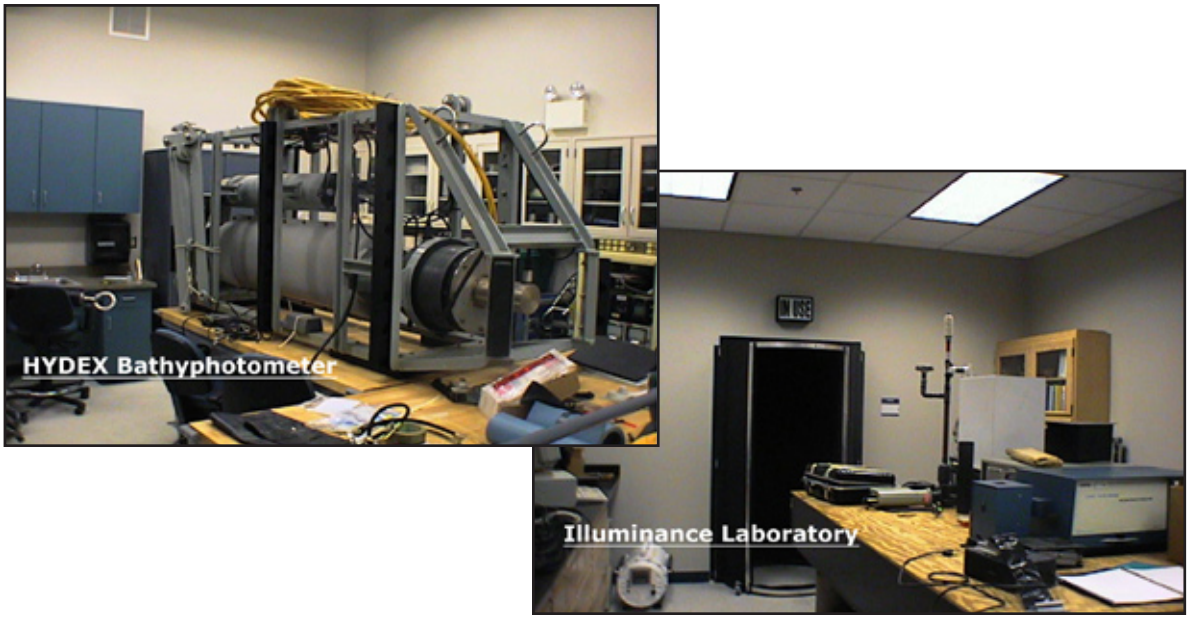
INSTRUMENTATION:

- Bridgeport vertical milling machine; Tradesman bandsaw
- MIG-TIG welding machine (Shopmaster 300)
- NARDINI MASCOTE MS-1440 precision lathe
- 2-ton Presto PSTA2107 Pallet Stacker
- 2-ton overhead monorail crane.

DESCRIPTION: To achieve a consistently high level of data quality from field experiments, seagoing measurement systems are required to endure harsh marine environments and to operate with their designed measurement capability throughout the deployments. This requires continuous maintenance efforts including calibrations, adjustments, tunings, modifications, and storage for electronic and mechanical components of various seagoing systems during the pre- and post-deployment stages. These functions are conducted in this facility consisting of an electronic assembly and readiness lab, machine and welding lab, sensor calibration lab, 1500-ft^2 experiment staging area (high-bay), and temperature-control storage center. It is of essential importance for maintaining the readiness and integrity of the NRL measurement systems.

CONTACT:
Code 7332 • (228) 688-4708
LOCATION:
NRL, Stennis Space Center, MS

Ocean Optics Instrumentation Systems



Ocean Optics Instrumentation Systems

FUNCTION: Provides instrumentation suites for a wide variety of measurements to characterize the ocean's optical environment. These packages have been developed to measure optical characteristics from the bioluminescent potential of the depths to the radiometric properties of the sea surface.

INSTRUMENTATION: Measurements of the inherent optical properties of attenuation, absorption, and scattering are routinely performed in the field, in addition to the measurement of the apparent radiometric quantities of radiance and irradiance. Instruments include WETLabs AC9 (9 wavelength attenuance and absorption meters); WETLabs ECOVSF and VABAM (angular dependent scattering); Satlantic SPMR (SeaWiFS wavelength radiance and irradiance profiles); Satlantic HTSRB and K-Chain (near-surface hyperspectral near-surface light field); HYDEX (bioluminescence potential); WETLabs SAFire (multiple wavelength; SeaTech CHL a fluorometers; ASD radiometers (surface-leaving radiance and reflectance).

The integration of these instruments into oceanographic measurement packages and data acquisition systems is an ongoing process at NRL's Ocean Optics facility.

DESCRIPTION: The ocean surface photic region is of prime interest to the Navy and NASA as it relates to ocean color from satellite and biological application in numerical modeling. Recently, small, lightweight packages have been developed for use in the near-shore coastal water. NRL also maintain capabilities for open-ocean measurements, airborne remote sensing, and airborne expendable optical systems.

CONTACT:
Code 7333 • (228) 688-5253
LOCATION:
NRL, Stennis Space Center, MS

Marine Geosciences Division

- Electron Microscopy Facility
- Sediment Physical and Geoacoustic Properties and Sediment Biogeochemistry Laboratories
- Marine Biogeochemistry Laboratory
- Computed-Tomography Scanning Facility
- Moving-Map Composer Facility
- AUV Prototype Development Facility

Electron Microscopy Facility

JEOL JEM-3010 TEM

FUNCTION: Performs basic and applied research in areas of marine geosciences, geophysics, physics, and microbiology using microanalytical techniques.

INSTRUMENTATION: The facility has a 300 kV JEOL JEM-3010 transmission electron microscope (TEM) equipped with an energy-dispersive X-ray spectrometer (EDXS), a Gatan Model GIF200 (Gatan Imaging Filter) for energy-filtered imaging and electron energy loss spectroscopy (EELS), and scanning coils for scanning TEM mode. This TEM has a state-of-the-art environmental cell (EC) system with two interchangeable EC specimen holders. The center is also equipped with a 100 kV Hitachi H-600 TEM.

DESCRIPTION: The Electron Microscopy Facility has unique instrumentation in its EC-TEM system. The EC is of the closed-cell type and is fully computer-controlled. Unlike EC systems based on the principle of differential pumping, closed-cell EC systems require no modification to the TEM. Confinement of the pressurized environment within the EC is achieved with electron-transparent windows. Since the EC is self-contained within the specimen holder, the TEM can still be used for conventional transmission electron microscopy using conventional specimen holders without compromising resolution and analytical capabilities.

CONTACT:
Code 7400 • (228) 688-4877
LOCATION:
NRL, Stennis Space Center, MS

Sediment Physical and Geoacoustics Properties Laboratory

Sediment Physical and Geoacoustics Properties Laboratory

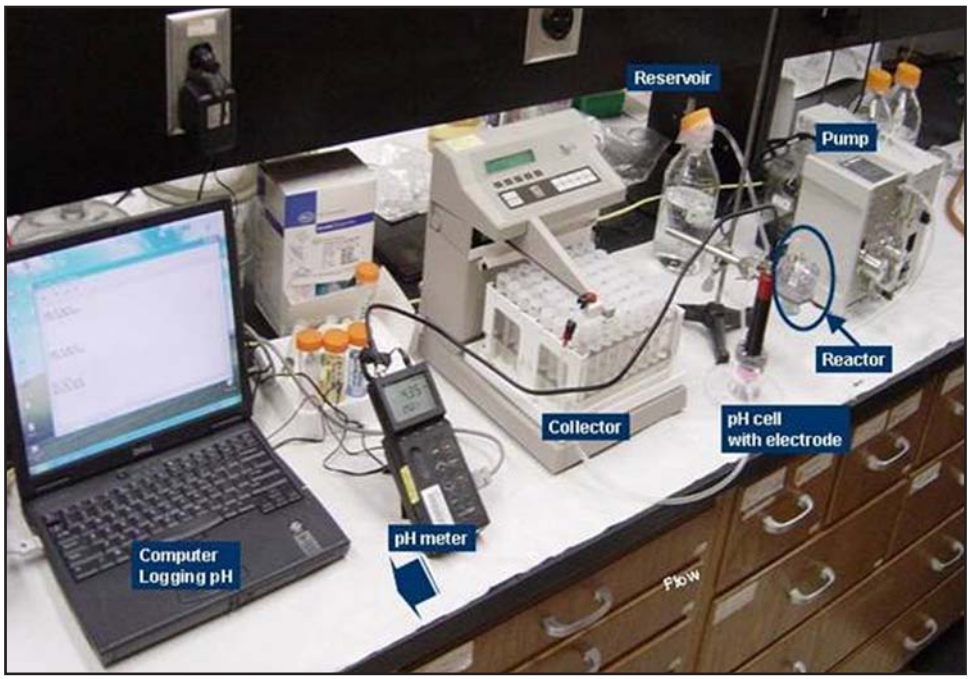
FUNCTION: Provides instrumentation and expertise for physical and geoacoustic characterization of marine sediments from all depths and regions of the oceans.

INSTRUMENTATION: A Geotek multisensor core logger, Faxitron X-radiography System, LABCONCO bulk tray freeze dryer, digital macro- and micro-photographic imagery systems, and geotechnical testing instrumentation that includes miniature vane shear and torvane, uni and triaxial consolidation instruments, geoacoustic Hamilton frame, relative density shaker table, and Quantachrome Penta- and Ultra-pycnometers. Sediment textural analyses are performed using sieves, pipette analysis, an instrumented settling tube, and a Micromeritics Sedigraph, Model 5120.

DESCRIPTION: The multisensor core logger measures profiles of compressional wave velocity, wet-bulk density (by gamma-ray attenuation), electrical resistivity, and magnetic susceptibility directly, and acoustic impedance and porosity indirectly; a digital X-radiography unit (Faxitron) provides images of sediment statigraphy, bioturbation, and inclusions. Sediment cores are opened for visual classification, measurement of undrained shear strength via miniature vane and torvane, and subsampling for physical properties tests. Grain-size analyses for coarse sediments are performed by settling tube or standard sieve analysis, and silt and clay size particles are analyzed by the Micromeritics Sedigraph. Average grain densities are measured via gas pycnometry using a Quantachrome Pentapycnometer. Geoacoustic properties are measured using 1-D consolidometers and triaxial testing machines.

CONTACT:
Code 7430 • (228) 688-5369
LOCATION:
NRL, Stennis Space Center, MS

Marine Biogeochemistry Laboratory



Marine Biogeochemistry Laboratory

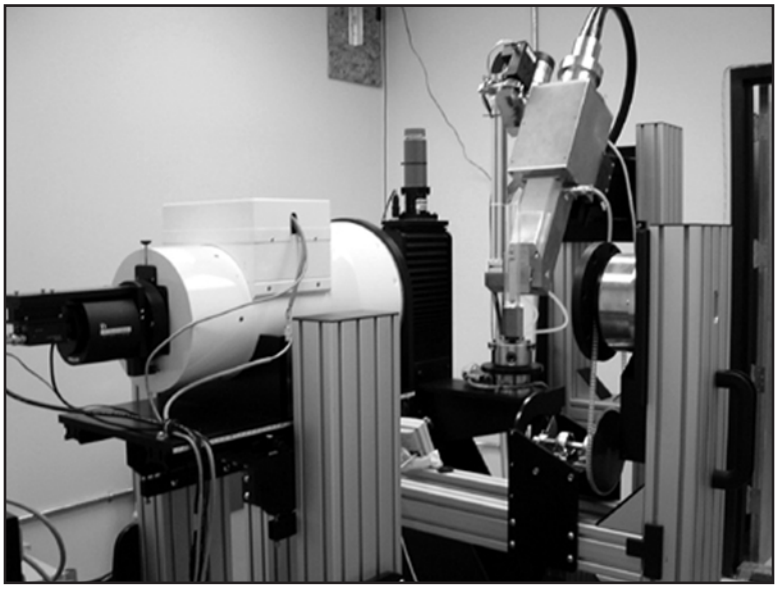
FUNCTION: Provides instrumentation and expertise for biogeochemical characterization of aquatic sediments.

INSTRUMENTATION: A heparin agarose affinity chromatography (HAAC) spectrophotometer, UV spectrophotometer, molecular biology systems (gel electrophoresis, electroporation, and RNA/DNA hybridization), inductively coupled plasma spectrometer (ICP), ion chromatograph (IC), zetasizer NanoZs with titrator, and an anaerobic chamber. A miscible-flow reactor with attached ancillary equipment (see above), centrifuges, and benthic mesocosms.

DESCRIPTION: The benthic mesocosms are used to simulate littoral seabed environments for the analysis of redox gradients in burrowed sediments. A miscible-flow reactor is used to investigate the reaction kinetics of a variety of mineral-microbe-water interactions. Spectrophotometers are used to analyze aqueous samples for the concentrations of dissolved species. Molecular biology systems are used to determine mechanisms for microbe-mineral interactions and microbial diversity in aquatic sediments. The zetasizer is used for nanoparticle characterization.

CONTACT:
Code 7430 • (228) 688-5474
LOCATION:
NRL, Stennis Space Center, MS

Computed-Tomography (CT) Scanning Facility



The X-ray system portion of the HD-500 Micro-CT System

FUNCTION: The Computed-Tomography (CT) Scanning Facility operates to advance research in the areas of marine geosciences, geotechnical, civil, and chemical engineering, physics, and ocean acoustics by using high-resolution, volumetric, X-ray imaging.

INSTRUMENTATION: The CT facility operates a HD-500 Micro-CT System, which is equipped with a microfocus X-ray tube that operates from 10 to 225 kV and 0 to 3 mA. This state-of-the-art industrial CT enables the production of images with 10 μm resolution for appropriately sized materials. The housing for this system is open, so that large systems (e.g., acoustic impedance tubes, permeameters, compression testers) can be used in conjunction with the CT System. In addition to the high-resolution CT system, the facility is equipped with a Picker Medical CT scanner, which operates at energies to 150 kV, can accommodate large diameter samples (up to ~0.75 m in diameter), and is housed in a portable trailer, which makes the system useful for field experiments. In each case, the energy spectrum is polychromatic.

DESCRIPTION: The Computed-Tomography Scanning Facility has the capability to produce high-quality fine-scale images of Navy relevant materials. This capability is equivalent to that of the synchrotron laboratories (~10 μm resolution for 1-cm diameter Earth materials). Additionally, this facility can accommodate small to large samples (i.e., 5-mm to 9-cm diamter with the HD-500). This facilitates the evaluation of similar systems at many scales, in a relatively short period of time. Furthermore, this facility promotes experiments that require weeks to months, so that processes that occur in dynamic systems over extended time periods can be evaluated (e.g., growth and migration of gas bubbles in mud, drainage/imbibition of water from/into beach sand, and evolution of stratigraphy in response to bioturbation). In these cases, physical conditions are altered, allowed to equilibrate and then CT-scanned.

CONTACT:
Code 7431 • (228) 688-5473
LOCATION:
NRL, Stennis Space Center, MS

Moving-Map Composer (MMC) Facility

Moving-Map Composer Facility

FUNCTION: Develops, tests, and transitions software and algorithms to perform data-base design, data compression, change detection, data fusion, archival, retrieval, and display. Demonstrates and evaluates prototype and next-generation digital moving-map capabilities, map design systems, and mission planning

INSTRUMENTATION: The MMC Facility includes multiple computer platforms running Unix, Linux, Windows NT, and OpenVMS operating systems.

DESCRIPTION: The MMC Facility is a 32 × 30-ft laboratory. The facility is divided into five primary work areas to support the principal functions of the MMC team:

- Research into data compression and database design
- Research and development of automated algorithms for change detection and object identification
- Development and transition of mission-specific aircraft optical disks for F/A-18 and AV-8B platforms
- Software and algorithm development in support of Naval mission and map planning
- Developing, testing, prototyping, and demonstrating parallel processing techniques to improve efficiency of existing bathymetric data processing systems.

CONTACT:
Code 7440.1 • (228) 688-4611
LOCATION:
NRL, Stennis Space Center, MS

AUV Prototype Development Facility

Autonomous Underwater Vehicle (AUV) Prototype Development Facility

FUNCTION: Develops, tests, and demonstrates approaches to cooperative autonomous multivessel navigation. Research emphasis is on underwater vessels, so acoustics are used for all intervessel communications.

INSTRUMENTATION: Three ActivMedia land robots equipped with PC104 computers, compasses, wireless network, speakers and microphones. Three radio-controlled model tug boats equipped with PC104 computers, wireless networks, compasses, GPS and underwater acoustic systems for signaling.

DESCRIPTION: This facility consists of two rooms, the robot lab, which is dedicated to land applications, and the boat lab. Having both land and water capabilities allows initial prototyping and testing of multivessel navigation concepts, first in a quiet, climate-controlled environment and then in the more difficult outdoor land or water environment. The robot lab is dedicated to the development and testing of systems and software for land robots, and includes an indoor test range, three PCs for remote monitoring and control of the robots, a camera-based positioning system, and a control/communications infrastructure linking the systems together. The control/communications infrastructure can be ported to laptops for outdoor land robot experiments. The second room is dedicated to the construction of the boats and testing of systems and software that will be installed on the boats. In-water testing of the underwater acoustic systems and the boats is conducted at an on-site National Oceanic and Atmospheric Administration (NOAA) pier facility located on a channel inside of a lock.

CONTACT:
Code 7440.5 • (228) 688-5321
LOCATION:
NRL, Stennis Space Center, MS

Marine Meteorology Division

- Meterological and Oceanographic Research Library
- Meteorological Computing and Archival Facility
- Atmospheric Prediction System Development Laboratory
- Mobile Atmospheric Aerosol and Radiation Characterization Observatory
- Satellite Data Ingest and Processing System

Meteorological and Oceanographic (METOC) Research Library

METOC Research Library

FUNCTION: This on-site library provides researchers with complete library functions with emphasis on meteorology and oceanography. Copies of scientific texts, reference books, and journals are on hand for the research needs of NRL and Fleet Numerical Meteorology and Oceanography Center (FNMOC) scientists. Interlibrary loans and on-line library access functions are also provided by the library.

INSTRUMENTATION: NRL Monterey shares the scientific library with FNMOC. The library contains many well-known historical and modern-day books on meteorology and oceanography. The library also serves as a repository for a number of internal technical publications, including technical reports from the laboratories that preceded NRL, namely the Naval Environmental Research Prediction Facility (NEPRF) and the Naval Oceanographic and Atmospheric Research Laboratory (NOARL). The METOC library also maintains historical and current copies of the graduate theses and dissertations written by students in meteorology and oceanography at the Naval Postgraduate School.

DESCRIPTION: This on-site library maintains current and past copies of most of the U.S. and many of the international journals dedicated to the atmospheric, oceanographic, and computational sciences; copies of NRL (NEPRF, NOARL) and FNMOC technical reports and memorandum; and a number of reference books and hundreds of scientific texts in the mathematical, physical, and Earth sciences. The facility also provides quiet reading and work areas, as well as a computer for on-line access to the Ruth H. Hooker Library, located at the Laboratory's main site in Washington, DC. NRL Monterey scientists are frequent users of the Research Library's InfoWeb gateway, which provides on-line access to a large number of journals and other publications.

CONTACT:
Code 7500 • (831) 656-4721
LOCATION:
NRL, Monterey, CA

Meteorological Computing and Archival Facility

Tape library of the Bergen Data Center

FUNCTION: Provides a data archival facility, the Bergen Data Center (BDC), for meteorological and oceanographic data. It also operates as a resource site for the Master Environmental Library (MEL), a distributed repository system of environmental information with a single user access site.

INSTRUMENTATION:The facility includes a SGI server, two Sun servers, and StorageTek tape libraries handling archives and backup for BDC. BDC storage capacity is 31 Terabytes. Veritas Hierarchical Storage Manager (HSM), Netbackup, and First Watch software packages are used to manage data storage.

DESCRIPTION: The MEL facilitates discovery, access, subscription, and delivery of environmental information, products, and data wherever they are stored. It supports models and simulations for training, analysis, and acquisition through a single user interface to numerous DoD and non-DoD resource sites. The MEL promotes interoperability among simulation users by facilitating reuse of environmental information, products, and data. The MEL supports the warfighter as well as the non-DoD and commercial communities. At the BDC, data older than 30 days are physically archived within the Hierarchial Storage Management (HSM) file systems but can also be retrieved logically online.

CONTACT:
Code 7501.1 • (831) 656-4892
LOCATION:
NRL, Monterey, CA

Atmospheric Prediction System Development Laboratory

Atmospheric Prediction System Development Laboratory

FUNCTION: Provides connectivity to computational platforms and databases that are necessary for the development, testing, and validation of numerical data assimilation and weather prediction systems. This capability allows for the rapid transition of software development into operations.

INSTRUMENTATION: The laboratory includes an in-house 128-processor computer, individual workstations, and high-speed connectivity which provides direct access to the operational supercomputer systems and data, and to the many computational resources at the various Department of Defense (DoD) Centers.

DESCRIPTION: This laboratory enables scientists at NRL to perform basic and applied research in numerical weather prediction and to take the knowledge learned from this research and quickly apply it to operational data assimilation and prediction systems. The facility allows the scientists to use the same software and databases in all their research that is used in operations at FNMOC, an important component necessary for the improvement of the data assimilation and prediction systems. The high-speed connectivity between the computational resources allows the scientists to share databases, results, and software. A number of offices at NRL Monterey are wired directly into the FNMOC Local Area Network, which allows developers to access and use computational resources (controlled by operating systems with multilevel security) that will ultimately host the NRL-developed weather prediction systems.

CONTACT:
Code 7530 • (831) 656-4788
LOCATION:
NRL, Monterey, CA

Mobile Atmospheric Aerosol and Radiation Characterization Observatory (MAARCO)

MAARCO

FUNCTION: MAARCO is designed as a stand-alone facility for both basic atmospheric research and the collection of data to assist in validating aerosol and weather models. Its purpose is to enable research on atmospheric aerosols, gasses, and radiation (visible and IR light) in areas of key interest, including remote areas, overseas locales, and onboard ships. This complete mobile laboratory facilitates deployment in areas with limited facilities, and provides maximum flexibility for integration of additional instrumentation.

INSTRUMENTATION: MAARCO contains an integrated suite of meteorology, aerosol, gas, and radiation instruments, with space maintained for guest instrumentation. The radiation suite includes an AErosol RObotic NETwork (AERONET) Sun Photometer, solar and IR radiometers, a Total Sky Imager, and a Micro-Pulse Lidar. A 3-wavelength Nephelometer, Aerodynamic Particle Sizer, total suspended particulate (TSP) filter sampler, tapered element oscillating microbalance (TEOM) sampler, SO2 and Ozone Monitors, and a microorifice uniform deposit impactor (MOUDI) sampler complete the aerosol and gas suite. Meteorological data are provided by a weather station, and a Rawinsonde System.

DESCRIPTION: MAARCO is a modified 20 ft x 8 ft climate-controlled container, which is a standard size certified for shipping. Removable scaffolding on the roof, and shelves and racks inside the container facilitate installation, removal, and stowage of instruments for shipping. MAARCO's radiation instruments provide spectral aerosol optical depths and inversion products, direct and diffuse total solar and infrared radiation, and real-time whole-sky images and cloud cover. The aerosol instruments characterize the light-scattering properties of atmospheric aerosols and provide data on aerosol particle sizes, aerodynamic shapes, concentrations, mass, elemental composition, and particle morphology. The gas monitors measure reactive compounds that modify aerosol particles and provide clues to the air mass origin. The Lidar and Rawinsonde System displays the vertical structure of clouds and aerosols, produces atmospheric extinction and optical depth profiles, and is valuable for locating atmospheric layers for aircraft sampling and assisting in interpreting the visible and IR instrument data.

CONTACT:
Code 7534 • (831) 656-4725
LOCATION:
NRL, Monterey, CA

Satellite Data Ingest and Processing System

Antenna receiving geostationary satellite data

FUNCTION: Collects and processes a unique global digital data set from multiple satellite sensors. The facility enables researchers to rapidly collocate multiple satellite sensors/channels for a wide range of Meterological and Oceanographic (METOC) applications anywhere on the globe. Hardware/software compatibility with the Fleet enhances rapid prototyping and transition to operations.

INSTRUMENTATION: The facility includes two geostationary receiving systems to capture real-time Geostationary Operational Environmental Satellite (GOES)-West and GOES-East data. A polar orbiter antenna system collects data from National Oceanic and Atmospheric Administration (NOAA) and Defense Meteorological Satellite Program (DMSP) satellites. A suite of Unix workstations and software process these data streams and data from three other geostationary and four global polar orbiter satellite data sets. Collaborative agreements with other government agencies significantly reduce on-site infrastructure needs.

DESCRIPTION: The facility includes rooftop antennas to capture real-time GOES-West and GOES-East digital data. The ~30 GB/day/satellite data rate flows through hardware to frame and bit-sync the data located in the computer room. Digital data from three other geostationary satellites (MTSAT, Meteosats-8 and 5) are gathered from the Fleet Numerical Meteorology and Oceanography Center (FNMOC). The five geostationary satellites thus enable true global coverage with visible, infrared, and water vapor channel data using SeaSpace's TeraScan software.

Real-time DMSP and NOAA polar orbiter satellite data are captured via an SMQ-11 System. NOAA data are available from a similar system in Norfolk, VA. Global near-real-time DMSP polar orbiter data are also gathered via FNMOC. Near-real-time Tropical Rainfall Measuring Mission (TRMM) and Moderate Resolution Imaging Spectroradiometer (MODIS) polar orbiter data are collected from the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center.

CONTACT:
Code 7541 • (831) 656-4833
LOCATION:
NRL, Monterey, CA

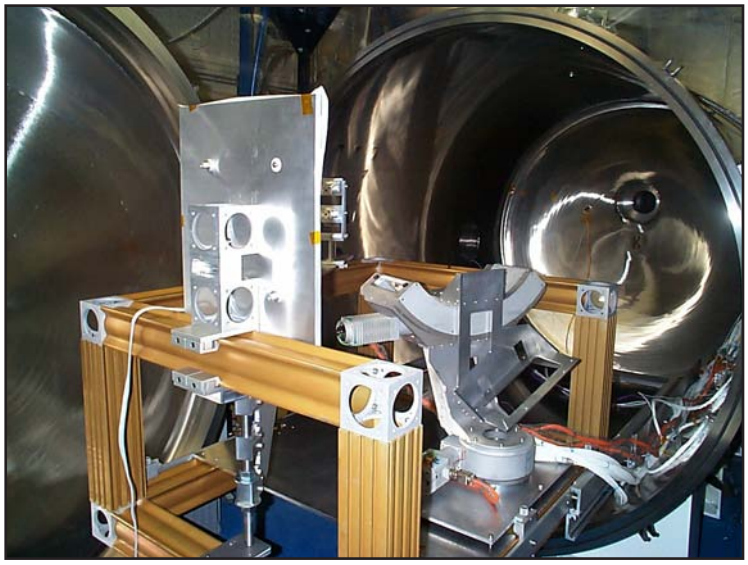
Space Science Division

- Vacuum Ultraviolet Calibration/Testing Facility
- Gamma-Ray Imaging Laboratory
- Cryogenic Sensor Test Facility
- The Large Angle and Spectrometric Coronagraph
- Rocket Assembly and Checkout Facility
- Solar Coronagraph Optical Test Chamber
- Space Instrument Test Facility
- EUV/X-Ray Calibration Facility

Vacuum Ultraviolet Calibration/Testing Facility

FUNCTION: Provides an oil-free high vacuum chamber for vacuum ultraviolet calibration and testing of extreme and far ultraviolet (FUV) sensors. The system is used to determine an instrument's optical characteristics by simulating the naturally occurring diffuse airglow emissions of the Earth's upper atmosphere. It is also capable of performing component-level testing and characterization of an instrument's individual optical components before instrument assembly.

INSTRUMENTATION: The facility consists of three vacuum vessels specifically designed for the fabrication and testing of sensors and components operating in the 80 to 170-nm spectrum. The primary vacuum vessel is a 1.67-m diameter by 2-m long stainless-steel tank. This chamber is evacuated using oil-free cryogenic, turbo, and roughing pumps with a typical operating pressure of 1 x 10^{-6} Torr. UV radiation is delivered into this system using two gas discharge lamps. The lamps can be configured for directed beam applications or as a diffuse source or for both simultaneously. Inside the chamber are several motion stages for remote positioning of the instrument or components being tested. Positively charged ions can also be injected into the chamber with energies up to 3 keV to test an instrument's susceptibility to a charged environment. Also attached is a rare gas analyzer to monitor outgassed contaminants from the items under test. Another vacuum vessel in the facility includes a chamber for independently testing and assembling FUV sealed tube detectors. The facility includes a vacuum chamber dedicated to the deposition of thin-film photocathodes and a 0.6-m diameter chamber for thermal vacuum testing components or small instruments that require stimulation of UV radiation.

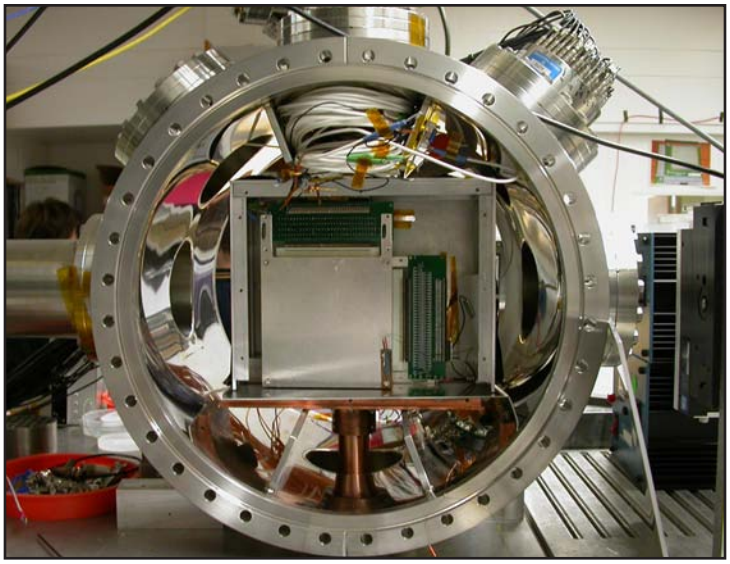


Vacuum Ultraviolet Calibration/Testing Facility

DESCRIPTION: The Vacuum Ultraviolet Calibration/Testing Facility is a series of clean vacuum chambers capable of generating and detecting UV radiation required for optical calibration of space experiments. It was built to support the optical development, testing, and calibration of the Special Sensor Ultraviolet Limb Imager (SSULI). It has also been used to test and calibrate other instruments such as the Tiny Ionospheric Photometer (TIP), the High-resolution Ionospheric and Thermospheric Spectrograph (HITS), the Remote Atmospheric and Ionospheric Detection System (RAIDS), and the Ultraviolet Imager (UVI). Using an advanced graphical interface, the facility can be easily reconfigured for a wide variety of UV measurements. A silicon carbide reflection diffuser provides diffuse radiation in the far and extreme UV portion of the spectrum. Calibrated reference detectors monitor the radiation levels during an experiment. Inside the chamber, precision translation and rotation stages allow motion of the test component along four independent axes. To minimize contamination, the end of the vacuum chamber is inside a Class 1000 clean room. The entire facility can be used interactively, and work is in progress to automate the facility to allow remote monitoring via a network connection.

CONTACT:
Code 7607 • (202) 767-5041
LOCATION:
NRL, Washington, DC

Gamma-Ray Imaging Laboratory



Vacuum test cryostat with a prototype germanium strip detector

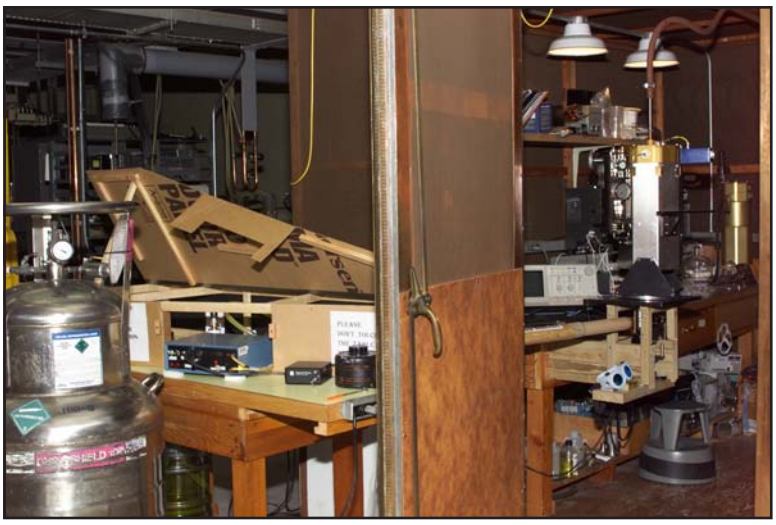
FUNCTION: The Gamma-Ray Imaging Laboratory is used for designing and testing high-resolution solid-state detectors used in imaging and spectral measurements of X-rays and gamma rays. The laboratory facilities include cryostats and electronics to test highly segmented detectors made from silicon or germanium. The segmentation into strips or pixels provides position sensitivity used in reconstruction of the gamma-ray image. The data acquisition system can support test configurations with up to 400 channels of low-noise electronics.

INSTRUMENTATION: Several cryostats and associated cryogenic systems provide a controlled temperature environment for detector performance testing from 75 K to room temperature. The cryostats provide cold finger mounting of the detector under test and a volume for mounting low-noise electronics at an intermediate temperature. Up to 100 signals can pass through the cryostat wall to a Versamodule Eurocard (VME)-based signal processing and digitization system. Aperture windows in the cryostats permit probing of the detectors using collimated gamma-ray beams from radioactive sources that are mounted on a computer-controlled external positioning system. Two separate large environmental chambers are available to test gamma-ray detectors down to –70 °C.

DESCRIPTION: The Gamma-Ray Imaging Laboratory provides the resources necessary to test new detector concepts for high sensitivity measurements of X rays and gamma rays. Much of the work in the laboratory has focused on developing large arrays of intrinsic silicon, lithium-drifted silicon, or germanium detectors that have been segmented into strips or pixels to provide interaction position information necessary for imaging. These detectors provide significantly improved capabilities for detection of natural gamma radiation on Earth as well as in space: for the measurements of X- and gamma-ray emission in solar flares, and astronomical sources of gamma rays such as novae and supernovae and active galactic nuclei; for homeland defense and DoD application in the detection of shielded nuclear materials; and for nuclear medical imaging, both SPECT (Single Photon Emission Computed Tomography) and PET (Positron Emission Tomography).

CONTACT:
Code 7651 • (202) 767-3572
LOCATION:
NRL, Washington, DC

Cryogenic Sensor Test Facility



Laser photon source and He-3 cryostat in a shielded room

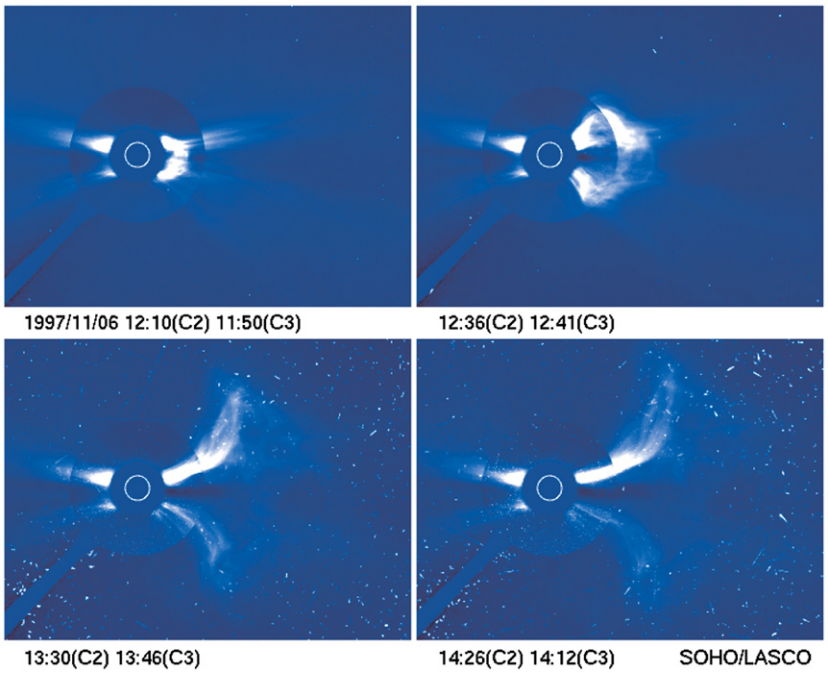
FUNCTION: Used for designing and testing hyperspectral (IR to X-rays) single-photon cryogenic detectors. These detectors can measure the "color" (energy) of individual photons without using dispersive elements such as diffraction gratings. The accuracy can be as high as 1 part in 10,000 for a 10-keV photon. The facility provides a cryogenic environment for the detectors, ultra-low-noise electronics, and a fast acquisition system.

INSTRUMENTATION: The He-3 cryostat provides access to temperatures as low as 0.3 K. An X-ray source (Fe-55) can be placed inside the cryostat and covered or uncovered by external control. The cryostat has windows adjustable to external IR/visible/UV photons. A custom Nd-YAG laser (infrared radiation: λ=1.06 μm) with frequency doubling (green: λ=532 nm) and tripling (UV: λ=353 nm) produces trains of sub-nanosecond pulses. Cryogenic electronics include Superconducting Quantum Interference Device (SQUID)-array amplifiers, with current noise of 2 pA/Hz$^{1/2}$, bandwidth up to 1 GHz, input impedance of 4 to 250 nH, and trans-impedance gain 100 to 1000 Ω.

DESCRIPTION: The Cryogenic Sensor Test Facility is an electromagnetically screened room with a sub-Kelvin temperature cryostat, photon sources (X-ray, UV, optical and infrared photons), very low noise cryogenic and room temperature electronics, and a signal processing system. It was built to support the development of non-dispersive single-photon detectors. These are currently hyperspectral single-photon energy resolving (QVD) detectors, which can cover a wide range of wavelengths from X rays to IR. In the QVD design, the energy deposited by a photon into the detector is thermoelectrically converted into the voltage with subsequent digital readout at the cold stage for a multipixel array configuration. Since the QVD is still at the developmental stage, the facility is very flexible and has tools and equipment that can be easily reconfigured and upgraded.

CONTACT:
Code 7655 • (202) 767-2506
LOCATION:
NRL, Washington, DC

The Large Angle Spectrometric Coronagraph (LASCO)



Images of a coronal mass ejection that occurred on November 6, 2000

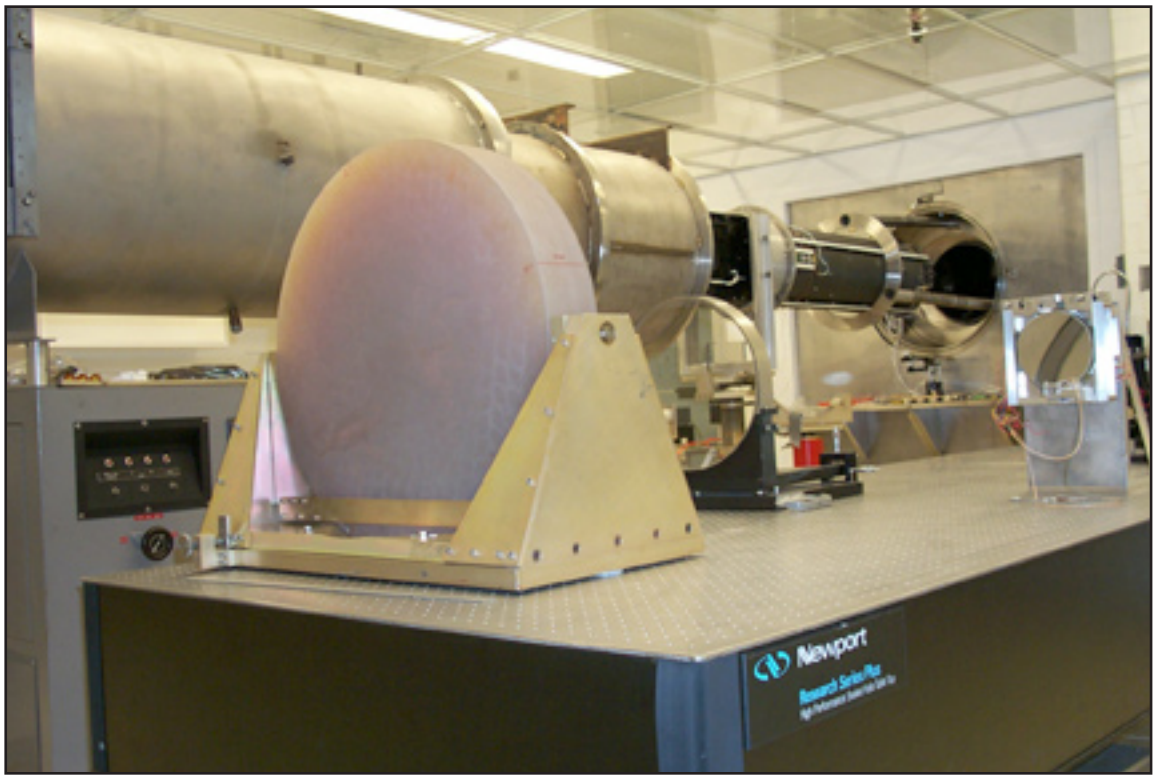
FUNCTION: Designed to answer some fundamental questions: How is the corona heated? Where and how is the solar wind accelerated? What causes coronal mass ejections, and what role do they play in the evolutionary development of large-scale coronal patterns?

INSTRUMENTATION: The LASCO instrument is a suite of three coronagraphs that image the solar corona from 1.1 to 32 solar radii (about 1/7 of the distance to Earth). It is convenient to measure distances in terms of solar radii. One solar radius is about 700,000 km, 420,000 miles, or 16 arc min. The Extreme-ultraviolet Imaging Telescope (EIT) instrument images the solar disk to 1.5 solar radii in four narrow wavelength intervals from 17.1 to 30.4 nm. These intervals roughly correspond to ionization temperatures of 60,000 K to 3 MK.

DESCRIPTION: The LASCO and EIT instruments are 2 of 11 instruments included on the joint National Aeronautics and Atmospheric Administration/European Space Agency (NASA/ESA) SOHO (Solar and Heliospheric Observatory) spacecraft. SOHO was launched on December 2, 1995 at 0808 UTC (0308 e.s.t.) from the Kennedy Space Center, Cape Canaveral, Florida. The spacecraft is located about 1 million miles from Earth, between Earth and the Sun in a halo orbit about the L1 Lagrangian point. This point is where the gravitational and orbital forces are balanced. About 250 images are returned from LASCO and EIT each day, providing unprecedented views of the Sun and its corona, recording the source of major geomagnetic storms.

CONTACT:
Code 7660 • (202) 767-2263
LOCATION:
NRL, Washington, DC

Rocket Assembly and Checkout Facility



Rocket Assembly and Checkout Facility

FUNCTION: Integrates, tests, and calibrates scientific instruments flown on sounding rocket payloads. The scientific instruments are assembled on an optical bench; the electronic components are installed and tested; and the instrument is moved to the vacuum calibration chamber for spectroradiometric calibration. When removed from the chamber, the payload is ready for shipment to White Sands Missile Range (WSMR), New Mexico, for integration with the spacecraft and launch vehicle.

INSTRUMENTATION: The facility includes air hood, ultrasonic cleaner, particle counter, oscilloscope, and flight instrument computers.

DESCRIPTION: The facility consists of six contiguous laboratory modules subdivided into a storage area, a gray room area, and a clean room. The storage area houses spare instrument components and intermittently used ground support equipment. The gray room area contains facilities to clean components before they enter the clean room and equipment used to ship the instrument to WSMR. The Class 100 cross-flow clean room is separated from the gray room by an air shower. The clean room contains three major stations: a clean bench for assembly of subsystems; a 12 × 4-ft optical bench for instrument assembly and electronic test of the instrument subsystems; and a vacuum chamber for vacuum focus and spectroradiometric calibration. The cryogenically pumped vacuum chamber is designed with a 30-cm diameter ultraviolet collimator at one end and a roll-off section that accommodates the entire flight instrument centered in the collimated beam at the other end.

CONTACT:
Code 7660 • (202) 767-2093
LOCATION:
NRL, Washington, DC

Solar Coronagraph Optical Test Chamber (SCOTCH)

Solar Coronagraph Optical Test Chamber

FUNCTION: Provides a facility for the assembly, test, and vacuum optical characterization of solar and coronal satellite instrumentation under ultraclean conditions.

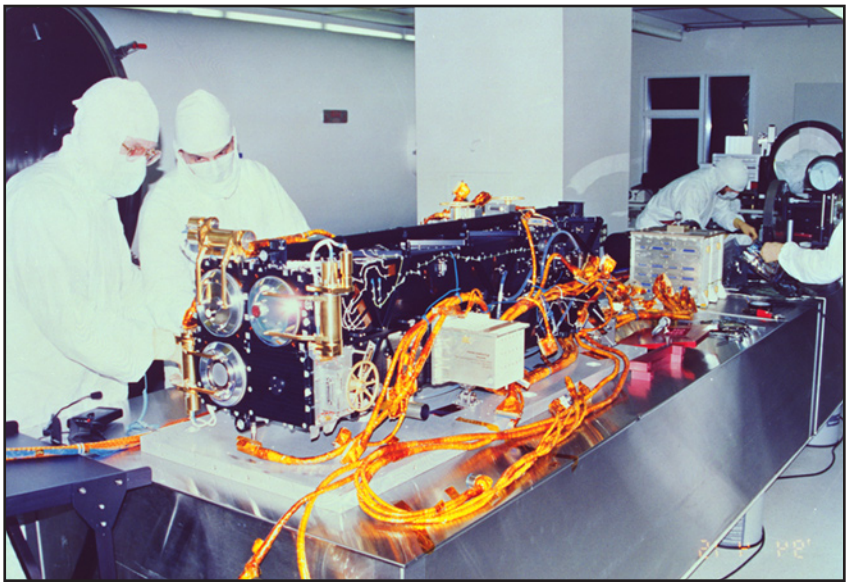
INSTRUMENTATION: The SCOTCH is instrumented with temperature-controlled quartz crystal monitors and residual gas analyzers for real-time, quantitative measurements of volatile contamination. Various light sources can be introduced at one end of the 11-m chamber. This includes a solar spectrum simulator as well as other visible and extreme-ultraviolet (XUV) sources. The chamber contains an instrument-pointing table capable of supporting payloads with a mass of 75 kg. The precision of the pointing table is less than 1 arc-second.

DESCRIPTION: The large SCOTCH is the primary test chamber located within a 400-ft^2 Class 10 clean room. This completely dry-pumped, 550 ft^3 vacuum chamber is maintained at synchrotron levels of cleanliness. Solar instrumentation up to 1 m in diameter and 5 m in length can be physically accommodated in the chamber. An instrument's optical performance is probed and calibrated with a variety of visible and XUV sources mounted on the chamber's 11-m beamline. The instrument is mounted on a precision pointing table equipped with motorized slides, which allows controlled adjustment of instrument pointing with sub-arc-second precision under evacuated conditions. The main beamline is baffled to eliminate stray reflections from the beamline walls and minimize the effect of light scattered off the instrument surfaces. A solar disk stray light rejection of 10^{-12} was successfully measured in the Large Angle Spectrometric Coronagraph (LASCO) C3 channel.

CONTACT:
Code 7660 • (202) 767-3134
LOCATION:
NRL, Washington, DC

Space Instrument Test Facility (SITF)

FUNCTION: Enables flight optics and sensors to be assembled and tested under conditions designed to minimize particulate and volatile contamination of the flight hardware. Contamination causes significant optical and detector performance degradation over mission lifetime; by keeping contamination at acceptable levels, we avoid such degradation. The SITF was used for the test and assembly of the Large Angle Spectrometric Coronagraph (LASCO) and is currently being used to develop and test the next generation of space-based solar instrumentation for the National Aeronautics and Space Administration (NASA) Solar Terrestrial Relations Observatory (STEREO) mission.



Space Instrument Test Facility

INSTRUMENTATION: The Solar Coronagraph Optical Test Chamber (SCOTCH) is instrumented with a temperature-controlled quartz crystal microbalance and a residual gas analyzer to monitor chamber and instrument outgassing. Various electrical and liquid nitrogen vacuum feed-throughs are available through ports in the tank. A large retractable bell jar pulls back into the Class 10 instrument clean room to provide access to the instrument pointing platform. To facilitate instrument handling, assembly, and alignment operations, the clean room contains a 1.3 × 7-m vibration-isolated optical bench and an overhead crane adapted for clean room use with a 1-ton load capacity. A variety of calibrated optical sources, collimators, and theodolites are available to support in-air optical test, alignment, and assembly operations.

DESCRIPTION: The SITF provides a clean, controlled environment for the optical calibration and assembly of modern space-based solar instrumentation. The unique requirements of this instrumentation demand a rigorous approach to contamination control. The instrument vacuum test chamber, the SCOTCH, forms the primary optical test chamber and is described more fully on the previous page. The instrument handling and assembly is conducted in a Class 10 clean room to reduce particulate generation. Airborne particulate levels are continuously monitored. To prevent hydrocarbon contamination, the clean room air is filtered through activated carbon filters located in the central plenum ducts. The facility also contains a small, well-instrumented thermal vacuum/bake test chamber. This allows characterization of outgassing of components and subassemblies prior to integration in the main instrument structure.

CONTACT:
Code 7660 • (202) 767-3137
LOCATION:
NRL, Washington, DC

EUV/X-Ray Calibration Facility

EUV/X-ray Calibration Facility

FUNCTION: Provides an ultrahigh vacuum facility for the development and calibration of extreme-ultraviolet (EUV) and X-ray optics and instrumentation using monochromatic synchrotron radiation. Optical components such as mirrors, diffraction gratings, filters, and sensors as well as complete spaceflight and laboratory instruments are calibrated.

INSTRUMENTATION: The facility consists of a calibration chamber that is attached to the NRL beamline X24C at the National Synchrotron Light Source at Brookhaven National Laboratory. The chamber has inside dimensions of 63 in. long and 24 in. diameter and has various computer-controlled translational and rotational mechanisms for the remote manipulation of the test components and detectors. Turbomolecular and ion pumps provide ultrahigh vacuum conditions. The vacuum's cleanliness, important for preserving the functionality of EUV and X-ray optical components, is monitored by a thermoelectric quartz crystal microbalance (TQCM) and residual gas analyzer (RGA). Monochromatic radiation, with wavelengths of 1 nm through the ultraviolet and visible regions, is provided by the X24C beamline monochromator that is located approximately 15 m from the calibration chamber. The radiation beam is several mm in diameter, has low divergence, and spectral resolution of approximately 400. The beam is polarized with the electric vector in the horizontal plane, and this permits the measurement of the polarization response properties of the EUV and X-ray optics. Absolutely calibrated silicon photodiode detectors measure the incident beam intensity and the beam reflected, diffracted, or transmitted by the optical components. A 2 in.-square Complementary Metal-Oxide Semiconductor (CMOS) sensor provides high-resolution images of the beam. Monochromator wavelength scans and data collection are computer controlled.

DESCRIPTION: The facility has been used to calibrate EUV and X-ray optical components and complete instruments for spaceflight and laboratory applications. The spaceflight components include multilayer-coated diffraction gratings and mirrors for National Aeronautics and Space Administration (NASA) missions. Instrument calibrations include the EUV spectrometers for the Geostationary Orbiting Environmental Satellite (GOES) spacecraft. Gratings, mirrors, filters, and sensors have been calibrated for laboratory studies of the EUV and X-ray emissions from laser-produced plasmas at NRL and DOE laser facilities.

CONTACT:
Code 7674 • (202) 767-3529
LOCATION:
Brookhaven National Laboratory • Upton, NY

NAVAL

CENTER FOR SPACE TECHNOLOGY

Code 8100 – Space Systems Development Department

Code 8200 – Spacecraft Engineering Department

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Space Systems Development Department

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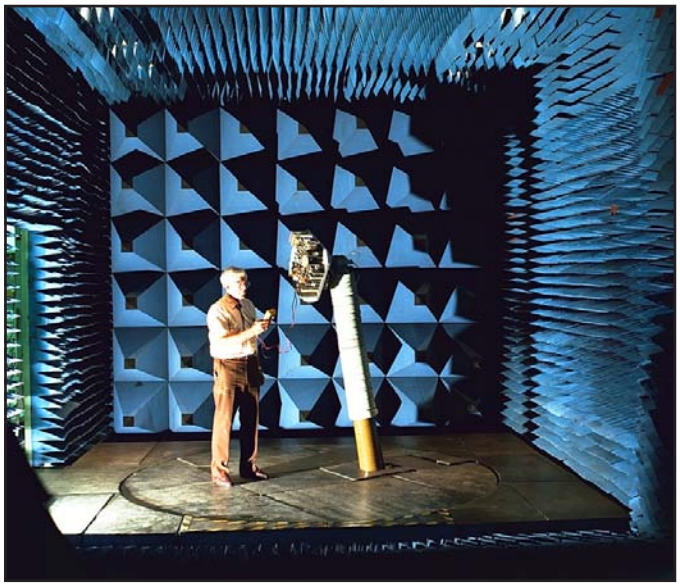
- Precision Clock Evaluation Facility

Precision Radio Frequency Anechoic Chamber Facility



Precision Radio Frequency
Anechoic Chamber Facility

FUNCTION: Performs measurements and calibration of antennas for satellites and aircraft or ground-based systems. The chamber is primarily used for optimizing antenna designs, configurations, and performance on satellites and ground planes. It produces 2-D and 3-D antenna patterns and swept voltage standing wave radio (VSWR) measurements in both hard-copy and soft-copy format. An associated program called STK (Satellite Tool Kit) can also be used to analyze the data in a simulated environment, using the measured antenna patterns.

INSTRUMENTATION: Antennas under test receive signals transmitted from the opposite end of the chamber by octave-band source antennas. Synthesizers and amplifiers feed the source antennas. Received signals are routed to an HP8510C network analyzer, where they are processed and sent to the control computer. The Flam and Russell 959 Automated Antenna Measurement System is used to control the HP8510C and the positioners and to perform the analysis and plotting.

DESCRIPTION: The Precision Radio Frequency Anechoic Chamber is a tapered structure, 44 ft long × 14 ft high × 16 ft wide, with a spherical quiet zone 5 ft in diameter. The quiet zone is specified to be isolated from the ambient RF environment outside by 150 dB. The chamber meets the performance specification requirements of free-space, voltage-standing, wave-radio, axial ratio, and reflectivity over the frequency range of 220 MHz to 40 GHz. Reflectivity levels inside the chamber are less than 50 dB from 1 to 40 GHz. The chamber is instrumented for automated measurement capability.

The chamber is inside a specially constructed electromagnetic interference facility shielded with 1/8-in. thick steel plates on all walls, floor, and ceiling. This provides 100 dB attenuation to RF signals from 50 MHz to 100 GHz.

CONTACT:
Code 8120 • (202) 767-6528
LOCATION:
NRL, Washington, DC

Satellite Mission Analysis Facility

Satellite Mission Analysis Facility

FUNCTION: Compares the on-orbit performance of complex systems against prelaunch and other baseline data. Supports telemetry, tracking, and control (TT&C) and other ground station requirements that cannot be accomplished by established tracking and control networks. The Pomonkey, Maryland facility can function semi-autonomously since design, fabrication, test, and calibration as well as other support functions are conducted within the facility.

INSTRUMENTATION: The facility maintains an inventory of very-low-noise front-ends, including special feeds, line elements, and amplifiers. These support the standard UHF, L, S, C, X, Ku, and Ka frequency bands as well as deep space frequency assignments. Operation centers house down-converters and other receiving equipment for signal acquisition within these bands. Special radiometric test equipment is used to verify efficiency, gain, and noise temperature of low-noise, high-gain receiving systems. Vector, scalar, and spectrum analyzers are available to ensure performance of newly developed subsystems and components. Fiber-optic links are widely available in support of high-speed connections.

DESCRIPTION: Pomonkey is a unique field laboratory with associated platforms and located 25 miles south of NRL near LaPlata, Maryland. The site occupies approximately 58 acres and is owned by NRL. It contains the largest high-speed tracking antenna in the United States and is suitable for low Earth orbit and deep space mission requirements. Other precision tracking antennas are available with apertures ranging from 1 to 9 m. Using special designs, Pomonkey can support operations over a wide band of frequencies from 50 to 25,000 MHz. Real-time signal enhancement and analysis capability has been developed for the facility, and specific operational analysis tools have been implemented to support a wide range of tasks. Operational systems at the facility are linked through several networks in a peer-to-peer environment. A primary network provides access to key systems at NRL and other agencies, while a second network supports operations conducted at the facility. Firewalls and switches protect the integrity of the systems. Precise ephemeris data of all catalogued objects are obtained from the Naval Network and Space Operations Command through automated communications.

CONTACT:
Code 8124 • (202) 767-1750 or (301) 870-3528
LOCATION:
Pomonkey, MD

Blossom Point Satellite Tracking and Command Station

Blossom Point Satellite Tracking and Command Station

FUNCTION: Provides simultaneous tracking and data acquisition, health and status monitoring, and command and control for NRL and Navy satellites. The site participates in the development of space systems, both satellite and ground elements, to support Navy mission requirements.

INSTRUMENTATION: The facility has five 20-ft parabolic antennas and two 33-ft parabolic antennas. There are eight satellite receive links and seven satellite uplinks. Command, control, and data storage are provided by 8 mainframe computers, 12 X Windows workstations, and approximately 95 GB of mass storage. Power is supplied by six redundant uninterruptible power supplies (UPSs) with a total rating of 284 kW. Emergency power is supplied by a redundant emergency generator.

DESCRIPTION: The Satellite Tracking and Command Station is located in Blossom Point, Maryland, in southern Charles County. The facility is contained on 41 acres located within the U.S. Army Research Laboratory's property bordering Nanjemoy Creek and the Potomac River. This location provides horizon-to-horizon look angles and an interference-free, low-noise environment. To prevent interference with the sensitive satellite antenna radio receivers, the Blossom Point Tracking and Command Station is protected by a 2000-ft-radius buffer zone.

The facility consists of 13 buildings totaling approximately 65,000 ft^2 of floor space that includes approximately 10,000 ft^2 of operational space.

The numerous site antennas receive data from and transmit commands to satellites. The station is in continuous operation 24 hours/day, 7 days/week, and supports numerous spacecraft.

CONTACT:
Code 8140.1 • (301) 870-3582
LOCATION:
NRL, Blossom Point, MD

Midway Research Center (MRC) Precision Spacecraft Calibration Facility

Precision Spacecraft Calibration Facility

FUNCTION: The MRC is a worldwide test range that provides accurate, known signals as standards for performance verification, validation, calibration, and anomaly investigation for national missions and other customers. In this role, the MRC ensures the availability of responsive and coordinated scheduling, transmission, measurement, and reporting of accurate and repeatable signals.

INSTRUMENTATION: The MRC system is normally configured to support specific customers; however, the system can be reconfigured in a reasonable time frame to support other needs. The MRC instrumentation suite includes nanosecond-level time reference to United States Naval Observatory (USNO), precision frequency standards, accurate RF and microwave power measurement instrumentation, and precision tracking methodologies. The instrumentation has been used for millimeter wave (MMW) projects. Classified and unclassified projects are supported. There is extensive computer control of all assets. The communications system handles wideband data, both classified and unclassified.

DESCRIPTION: The headquarters and primary site of the MRC are located on 162 acres in Stafford County, Virginia, contiguous to the Quantico Marine Corps Base. The main site consists of three 18.2-m, radome-enclosed precision tracking antennas and a variety of smaller antennas. The MRC has a large operation building and multiple other equipment and office buildings within a fenced compound. The MRC has the capability to transmit precision test signals, with multiple modulation types, from 20 MHz to 18 GHz (up to 40 GHz in an experimental mode). In addition to the primary site, the MRC is responsible for and controls multiple assets both in the United States and overseas. These assets include Pulstar systems (several worldwide locations), "The Dish" (a 45-m tracking antenna in Palo Alto, California), and "Marlock" (a 25-m tracking antenna system on Guam).

CONTACT:
Code 8146 • (703) 551-1992
LOCATION:
Midway Research Center • Stafford, VA

Precision Clock Evaluation Facility (PCEF)

Precision Clock Evaluation Facility

FUNCTION: Supports performance evaluation, environmental testing, including shock and vibration and anomaly investigation of on-orbit observed performance of high-precision atomic clocks for spacecraft, ground, and mobile applications.

INSTRUMENTATION: Four data collection systems were built by NRL and are used within the PCEF. The primary atomic clock measurement/data collection system is a 48-channel, dual-mixer phase measurement system capable of simultaneous measurements of 48 different clocks at 20-s intervals indefinitely. A single-channel, dual-mixer phase measurement system used for special evaluations is capable of measurements as short as 0.01 s. These data systems each have 2 ps of resolution. Software used in these systems was designed and coded by NRL, and includes analysis software with graphics and networking support for commercial products.

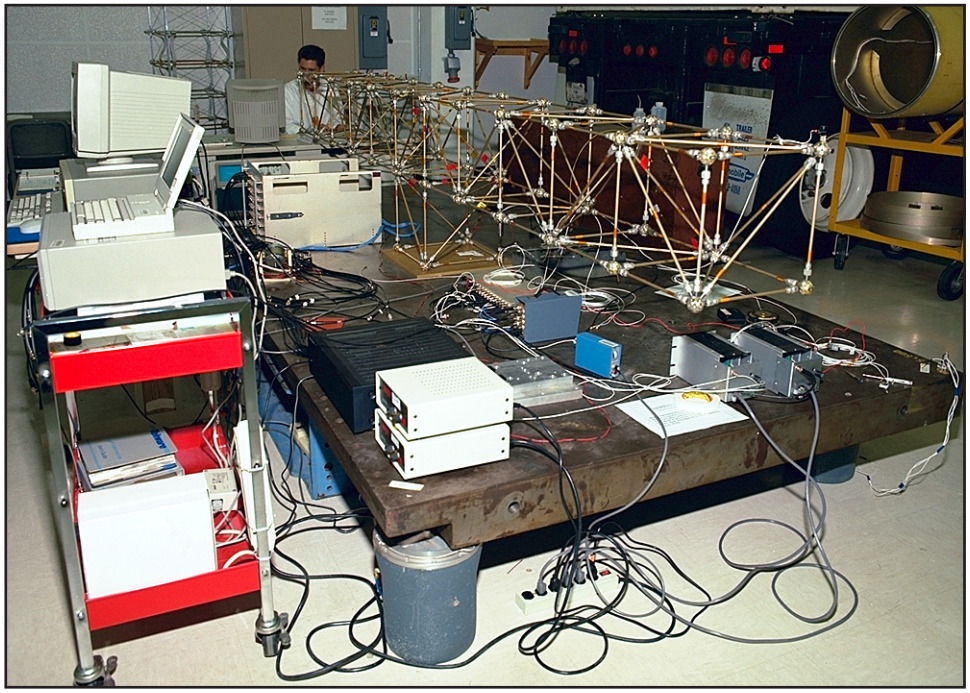
DESCRIPTION: The PCEF consists of time and frequency reference standards for comparison with test units that are made up of five active hydrogen maser frequency standards, three of which are housed in a large environmental chamber for humidity and temperature control. These references provide uninterrupted precise and accurate time/frequency with a stability of about 1×10^{-15} at 1 day and are maintained in synchronism with universal time coordinated (UTC) United States Naval Observatory (USNO) by several independent means. Eight spacecraft cesium and rubidium atomic, clock-sized thermal vacuum chambers specially designed for short- and long-term testing are used to simulate a spacelike environment (less than 1×10^{-6} torr) with temperature control of 0.1°C. To support long-term testing in a space environment, the test chambers and time/frequency standard references are operated on a 125-kW uninterruptible power system with diesel backup. Magnetic sensitivity testing of precision frequency standards is performed with two Helmholtz coil systems: a three-axis multicoil system and a single-axis 1.5-m Helmholtz coil.

CONTACT:
Code 8150.1 • (202) 767-5111
LOCATION:
NRL, Washington, DC

Spacecraft Engineering Department

- Modal Survey Test Facility
- Static Loads Test Facility
- Payload Processing Facility
- Thermal Vacuum Test Facility
- Spacecraft Acoustic Reverberation Chamber Test Facility
- Spacecraft Spin Test Facility
- Spacecraft Vibration Test Facility
- Spacecraft Thermal Analysis, Fabrication, and Test Facility
- Spacecraft Robotics Engineering and Controls Laboratory
- Class 100 Clean Room Facility
- Radio Frequency Anechoic Chamber Facility
- EMI Test Facility

Modal Survey Test Facility (MSTF)



Modal Survey Test Facility

FUNCTION: Provides the Naval Center for Space Technology (NCST) with the ability to perform modal survey testing on a wide variety of spacecraft and structures. The data acquired from the test enables the structural analyst to determine the dynamic characteristics of the test article. The test results may be used to correlate finite element models.

INSTRUMENTATION: A Hewlett-Packard VXI System with 288 channels of data acquisition provides the means for recording forces and acceleration responses during the modal test. A full complement of accelerometers, force transducers, and signal conditioning is available to support tests of all sizes. Results may be directed to SDRC's I-DEAS®, Matlab®, or other programs for final processing.

DESCRIPTION: The MSTF is located wherever the test article can be set up with appropriate boundary conditions. It depends only on sufficient space for mounting the test article and setting up the data acquisition system. The NCST's Environmental Test Facility offers space up to and including a structural test floor large enough to handle space shuttle-size payloads. Electromagnetic shakers of 75 and 250 lbf are available to provide excitation for the test.

CONTACT:
Code 8210 • (202) 767-3944
LOCATION:
NRL, Washington, DC

Static Loads Test Facility (SLTF)

Static Loads Test Facility

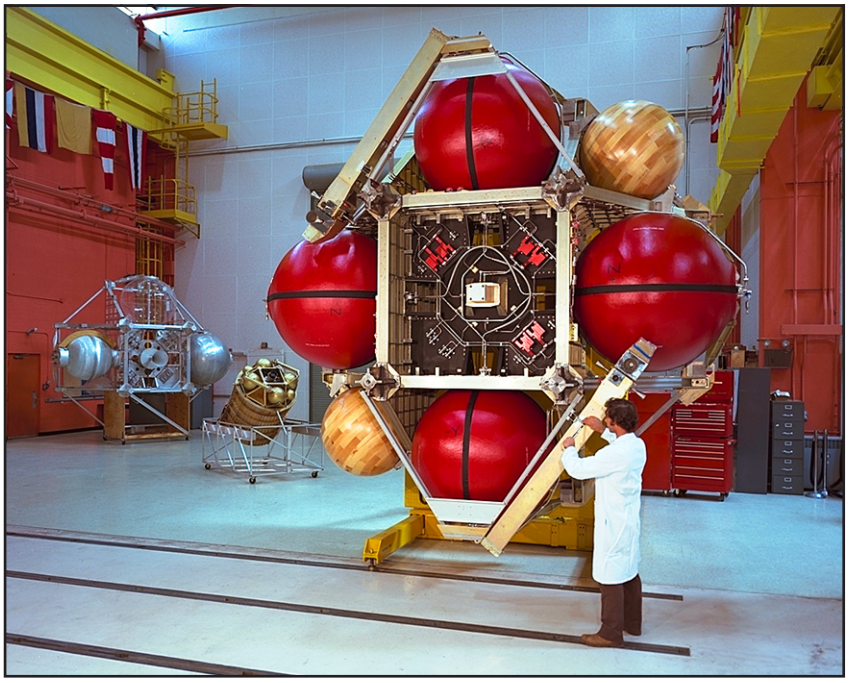
FUNCTION: Provides the Naval Center for Space Technology (NCST) and the Navy with the capability to perform large-scale structural loads testing on spacecraft and other structures. Results from these tests can be used to verify strength capabilities of the test article.

INSTRUMENTATION: Data acquisition is available for strain gages, linear voltage displacement transducers (LVDT), sonar displacement transducers, and load cells. An OPTUM Megadeck 200 data acquisition system provides the capability for collecting up to 400 strain-gage measurements. An OPTUM Megadeck 5733A 72-channel data acquisition system provides high-speed measurement capability. Facilities for light machining are also available. Additional facilities, hardware, and test equipment are available in the Environmental Test Facility to support testing.

DESCRIPTION: The SLTF consists of a 40 × 50-ft structural test floor, a structural steel fixture system, and a computer-controlled hydraulic loads application system. The test floor is located in a high-bay facility complete with an overhead crane. The crane has two carriages with 30,000-lb capacity each and approximately 30 ft of hook height. Areas adjacent to the test floor can be used for test article build-up and for test support activities. The test fixture system is an erector-set concept that allows for a wide variety of configurations to fit specific test needs. The load applications system can support up to 20 independent load strings with force capabilities from 3,000 to 100,000 lb.

CONTACT:
Code 8210 • (202) 767-3944
LOCATION:
NRL, Washington, DC

Payload Processing Facility (PPF)



Payload Processing Facility

FUNCTION: Provides a central location for all equipment and auxiliary machinery used to assemble and test space vehicles, subsystems, experiments, and components.

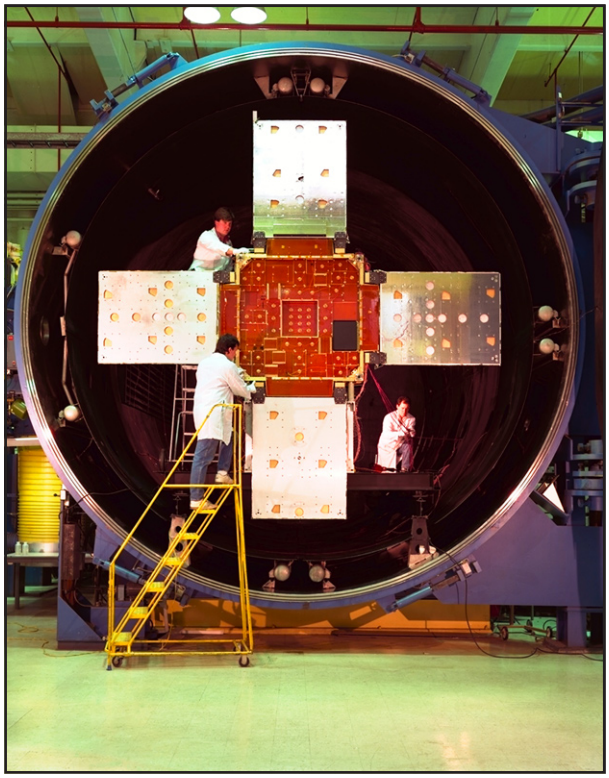
INSTRUMENTATION: The Payload Processing Facility (PPF) has a large array of mechanical aerospace ground equipment (MAGE), electrical aerospace ground equipment (EAGE), and spacecraft equipment/special test equipment (SE/STE) to support the myriad of tasks that occur during spacecraft assembly. The SE/STE include clean rooms (Class 100 –10,000), large isolated reaction masses, central heating, ventilation, and air conditioning (HVAC)/humidity control, liquid nitrogen (LN_2) and gaseous nitrogen (GN_2), supply, and extensive electrical power distribution and common grounding for equipment and ordnance.

DESCRIPTION: The PPF consists of a comprehensive laboratory complex housing a high-bay (13,500-ft^2, 40-ft high) assembly area, secure assembly support facilities, storage area, lifting equipment, fabrication machinery, and ground transportation equipment. The PPF houses the following environmental test facilities: acoustic reverberation chamber, random vibration, thermal vacuum, electromagnetic interference/electromagnetic compatibility/radio frequency (EMI/EMC/RF) chambers, optical alignment, modal survey, static loads, and spin balance. In addition, the PPF houses the Thermal Control Systems, Reaction Control Systems assembly and test facilities, Composites Fabrication Lab, and Heat Pipe Lab.

The assembly area serves as the fabrication, assembly, and integration area for spacecraft and flight hardware. Within the assembly area, structural assembly, wire harness assembly, component and subsystem integration, MAGE, and EAGE, checkout and debug occur.

CONTACT:
Code 8212 • (202) 767-0704
LOCATION:
NRL, Washington, DC

Thermal Vacuum (TVAC) Test Facility



Thermal Vacuum Test Facility

FUNCTION: Provides the capability to accurately simulate the space environment for the verification of thermal control system designs and the determination of thermal performance margins and capabilities of space vehicles, experiments, and subsystems.

INSTRUMENTATION: The facility has both computerized and manual control capability of the different chambers' thermal environments via the chamber shrouds and heaters, cold plates, and quartz lamps. Separate data acquisition systems exist for collection of up to 200 thermocouples, 100 resistance temperature detectors (RTDs), quartz crystal microbalances (QCM), and residual gas analyzer (RGA) measurements.

DESCRIPTION: The TVAC Test Facility is located within the Payload Processing Facility. It consists of three large chambers and several small chambers, a machinery room, a network of computers, a 26,000-gal liquid nitrogen (LN_2) storage facility, and an assortment of handling and test fixtures.

Of the three large chambers, chamber #1 is a 16-ft-diameter by 30-ft-long horizontal end-loading cylinder and chambers #2 and #3 are 7-ft-diameter by 8-ft-tall vertical bottom-loading cylinders. Chambers #1 and #2 are cryogenic pumped, providing an oil-free vacuum environment. Chamber #3 is a diffusion pump system capable of evacuation rates similar to the rates that occur during launch ascent. All three chambers are equipped with gaseous nitrogen (GN_2) conditioned thermal shrouds capable of temperatures between –150° to +125 °C. Numerous bulkheads are available for the pass-through of control, communication, power, and telemetry signals to the test setup.

CONTACT:
Code 8212 • (202) 767-0704
LOCATION:
NRL, Washington, DC

Spacecraft Acoustic Reverberation Chamber Test Facility

Spacecraft Acoustic Reverberation Chamber Test Facility

FUNCTION: Provides the capability to simulate the vibration and high-intensity, acoustic noise environment experienced by spaceflight hardware during the launch vehicle ascent.

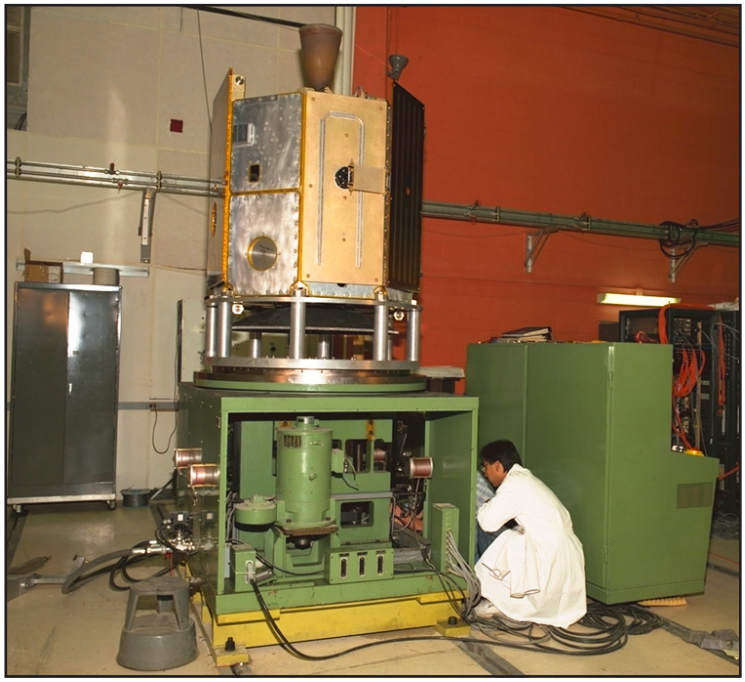
INSTRUMENTATION: Control of the chamber sound pressure level (SPL) is provided through a Spectral Dynamics 1500 acoustic controller connected to up to 12 microphones suspended within the chamber. For shaker vibration, a Spectral Dynamics 2550 provides control and limiting of up to 32 channels of accelerometer response. The facility has the capability to perform digital data acquisition of up to 300 channels using a HP VXI E1432 digitizer with I-DEAS® postprocessing.

DESCRIPTION: The acoustic reverberation chamber is located within the Payload Processing Facility and consists of: a 10,000-ft^3 test cell (17.2 ft wide × 21.5 ft long × 27 ft high), a 30,000-lb-force electrodynamic vibration shaker, a machinery room, a network of computers and amplifiers, a 26,000-gal liquid nitrogen (LN_2) storage facility, and an assortment of handling and test fixtures.

An SPL of 153 dB, with a range of 32 to 10,000 Hz, is attainable in the chamber. The 30,000-lb-force shaker has a 2-in. stroke and a 2,000 Hz upper limit and is mounted in the center of the chamber floor to provide mechanical vibration excitation in addition to acoustic excitation of test specimens.

CONTACT:
Code 8212 • (202) 767-0704
LOCATION:
NRL, Washington, DC

Spacecraft Spin Test Facility (SSTF)



Spacecraft Spin Test Facility

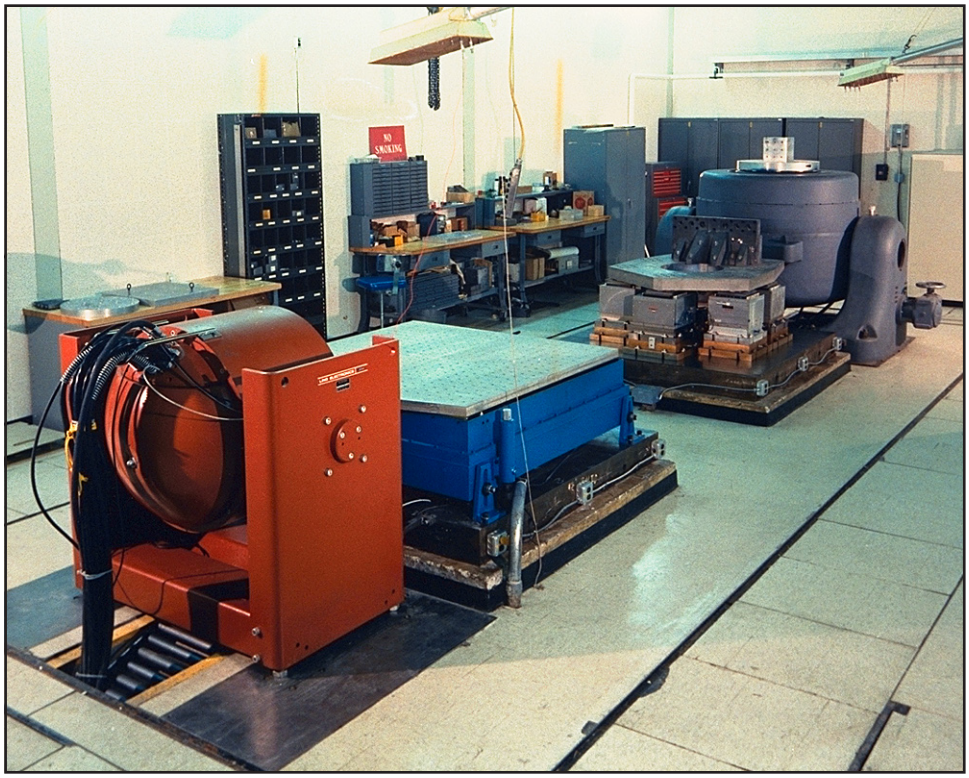
FUNCTION: Provides the capability of correcting unbalances of spacecraft by using dynamic measurement techniques and static/coupled measurements to provide products of inertia. Moments of inertia (MOI) can be determined on various capacity MOI tables.

INSTRUMENTATION: The vertical spin machine, a Schenk/Trebel model E-6 hydrostatic bearing spin table, has capacity up to 18,000 lb, spins at rates of 30 to 300 rpm, and is capable of 2 oz/in. accuracy. The horizontal spin machine is a Schenk/Trebel model FH600 horizontal hard-bearing spin table with a capacity of 13 to 1,300 lb, spin rates of 50 to 600 rpm, and 100 moz/in. accuracy. MOI tables include the Space Electronics models GB8000 (capacity of 8,000 lb), and 973-3000 (capacity of 3,000 lb). Both have an accuracy of ±0.5% of total MOI. We also have Inertia Dynamics MOI tables with 5-, 50-, 100-, and 200-lb capacities, with an accuracy of ±0.005% of total MOI.

DESCRIPTION: The facility contains two spin balancing machines (one horizontal and one vertical) to handle the various types of balancing requirements. Both machines are provided with a plane-separation network to obtain correction readings directly in the plane of correction. The spin machines require 100 ft^2 of space and are clamped to a slotted 4-ft-thick reinforced concrete floor for stability. Each machine has a remote control console to operate from a distance of 100 ft during hazardous operations. Various capacity MOI tables are used to verify MOI and center of gravity.

CONTACT:
Code 8212 • (202) 767-0705
LOCATION:
NRL, Washington, DC

Spacecraft Vibration Test Facility



Spacecraft Vibration Test Facility

FUNCTION: Qualifies and acceptance tests spacecraft and spaceflight components by simulating the various vibration loading environments present during flight operations and demonstrating compliance to design specifications. Using the facility's electrodynamic shakers, an assortment of quasi-static, vibratory, and shock loads can be generated, and test article characteristics can be quantified.

INSTRUMENTATION: A Spectral Dynamics 2550 provides control and limiting of up to 32 channels of accelerometer response. The facility has the capability to perform digital data acquisition of up to 300 channels using an HP VXI E1432 digitizer with I-DEAS® postprocessing.

DESCRIPTION: The Spacecraft Vibration Test Facility is located within the Payload Processing Facility and consists of four electrodynamic shakers (one 50-klb force, one 30-klb force, two 18-klb force), two slip tables, three individual power amplifiers, and a high-power switching system. The 50-klb, 30-klb, and one 18-klb shakers have an operational range of 5 to 2000 Hz response with 2-in. stroke capability.

CONTACT:
Code 8214 • (202) 767-0705
LOCATION:
NRL, Washington, DC

Spacecraft Thermal Analysis, Fabrication, and Test Facility

Spacecraft Thermal Analysis, Fabrication,and Test Facility

FUNCTION: Provides for the analytical thermal design and analysis of any spacecraft, including conceptual design, analytical thermal model development, definition of requirements, worst-case environments and design conditions, and temperature predictions for all cases. The facility provides, for any spacecraft, the means to turn an "analytical thermal design" into a working temperature control subsystem ready for flight (i.e., provides the means to go from design and analysis to hardware qualification and acceptance testing and then to orbit).

INSTRUMENTATION: A computerized data acquisition and control system (CDACS) is used during thermal testing for the display, collection, storage, and retrieval of temperature and power data, and for the automated control of all power supplies that feed various simulation heaters. CDACS consists of:

- Two workstations with displays
- Signal conditioners for over 1,000 thermocouple and low-voltage inputs
- 40 rack-mounted, digital power supplies with appropriate bus connectivity for output control.

DESCRIPTION: This facility provides computer support to accommodate six thermal analysts. The software required to create and run analytical thermal models include radiation exchange and orbital flux determination—Thermal Radiation Analyzer System/Thermal Synthesizer System (TRASYS/TSS); and thermal model formation and temperature prediction—Systems Improved Numerical Differencing Analyzer (SINDA). Thermo-optical surface properties of "real" surfaces must be known accurately for reliable temperature prediction. Thus, two types of reflectometers are used to measure short wavelengths for solar absorptions and long-wave infrared for room-temperature emittance. Detail thermal design and analysis is followed by fabrication and test phases. Capabilities within the facility include fabrication, assembly and qualification of flight hardware, and flight support. Technicians have expertise in the manipulation of all contemporary and advanced thermal control hardware including, but not limited to:

- Multilayer insulation materials (for thermal blankets)
- Flight-qualified temperature sensors, thermostats, and heaters.

This facility is capable of and has supported the incorporation of specialty technologies such as:

- Cryogenic thermal blankets and cryo coolers
- Diode, loop, constant, and variable conductance heat pipes
- Capillary pumped loops and other advanced two-phase systems.

CONTACT:
Code 8221 • (202) 404-7432
LOCATION:
NRL, Washington, DC

Spacecraft Robotics Engineering and Controls Laboratory

Spacecraft Robotics Engineering and Controls Laboratory

FUNCTION: Serves as a national test bed to support research in the emerging field of space robotics including autonomous rendezvous and capture, remote assembly operations, and machine learning.

INSTRUMENTATION: Dynamic Motion Simulator, with dual independent six-degree-of-freedom (DOF) platforms, provides the ability to test space robotic systems under realistic dynamic and lighting conditions.

DESCRIPTION: Operated by the Naval Center for Space Technology, with strategic support from the Naval Center for Applied Research in Artificial Intelligence, this is the largest dual-platform motion simulator of its kind. It allows full-scale, hardware-in-the-loop testing of flight mechanisms, sensors, and logic of space robotic systems. The simulator also supports the study of other complex relative motion problems.

Spacecraft orbit parameters, mass properties, and actuators, are modeled in the central computer to enable the simulator to replicate vehicle motion response to external disturbances and internal orientation and position commands. Actuator signals normally going to wheels or thrusters are continually processed to compute incremental force and torque components that force the platform to respond dynamically as a spacecraft would on-orbit.

CONTACT:
Code 8231 • (202) 404-3530
LOCATION:
NRL, Washington, DC

Class 100 Clean Room Facility

Class 100 Clean Room Facility

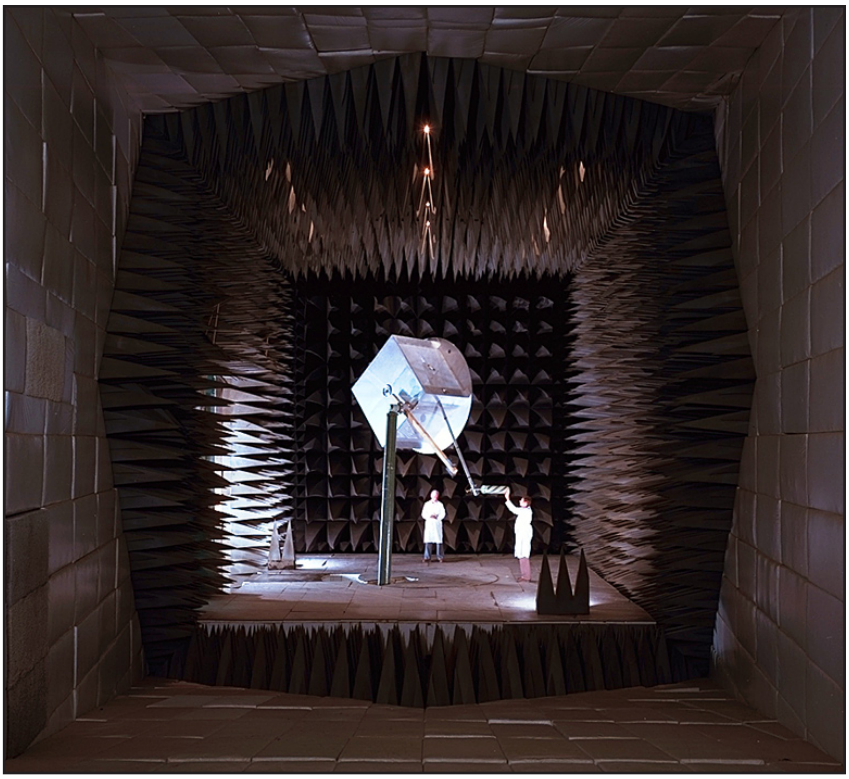
FUNCTION: Provides a Class 100 ultra-clean environment for the cleaning, assembly, and acceptance testing of contamination-sensitive spacecraft components and integration of complete spacecraft subsystems. The facility is used primarily to support spacecraft propulsion systems, but has been used to support all spacecraft electrical, electronic, and mechanical subsystems.

INSTRUMENTATION: The clean rooms are supported by an extensive array of special test equipment (STE) to support the needs of contamination-controlled testing and integration of spaceflight hardware. This STE consists of ultrasonic cleaning equipment, particle counting stations, water purification stations, vacuum drying stations, immersion flush stations, test hardware, electrical checkout stations, rinse stations, inert gas purges, dc power supplies, tooling and fixtures, and high- and low-pressure test panels for helium and nitrogen test gases.

DESCRIPTION: The facility consists of two self-contained rooms that have a footprint of 44 × 43 × 13 ft and an additional area for mechanical equipment that covers an area 43 × 20 × 13 ft, for a total volume of 35,776 ft^3. The entire work area is airtight; pressurized; and dust, temperature, and humidity controlled. It has two laminar flow rooms with an air velocity across the entire room of 100 to 120 ft/min. The air is filtered by using HEPA filters to an absolute level of 0.3 m. The rooms are environmentally controlled using air conditioning to achieve 65° to 75 °F and 40% to 60% relative humidity. The rooms are maintained at a minimum 0.15 in. of water pressure differential with existing atmospheric conditions. The High Bay Clean Room is a Class 10,000, 35 × 35 × 25 ft room with an 18-ft roll-up door that supports large spacecraft and propulsion system integration. This room connects to the precision Class 100 clean room and houses the propulsion orbital TIG welding operations for plumbing systems.

CONTACT:
Code 8232 • (202) 767-9168
LOCATION:
NRL, Washington, DC

Radio Frequency Anechoic Chamber Facility



Radio Frequency Anechoic Chamber Facility

FUNCTION: Supports the design, manufacture, and test of antenna systems. The facility is also used as an electromagnetic compatibility/radio frequency interference (EMC/RFI) test chamber.

INSTRUMENTATION: The chamber is controlled by a Scientific Atlanta SA-2095 automatic measurement system with low-frequency extension and millimeter-wave mixers, allowing measurements from 100 MHz to past 100 GHz. A transmit multiplexer allows single- or dual-polarization measurements to be made very quickly, and a receive multiplexer allows multiple antennas or antenna configurations to be measured in the same cut.

DESCRIPTION: The facility consists of a 12 x 20 x 10-ft EMC shielded room, machine shop tools and assembly area, and a shielded 120-ft anechoic chamber with a computer-controlled automated antenna measurement system. The chamber is 31 x 31 x 120 ft. It is pyramidal in shape and tapers to a conical section at the transmitting end. The back wall of the chamber is covered with 169 absorbing pyramids that are 9 ft. in length. The sides, ceiling, and floor are lined with 4-ft absorbing pyramids. The conical transition from the 31 x 31-ft test area to the apex is covered with a 2-ft wedge absorber. In the center of the floor is a 9-ft diameter pit that contains the large model tower. Also in the pit are two scissor lifts that move a section of the floor, allowing the tower to be lowered for the mounting of models and antennas at ground level.

CONTACT:
Code 8241 • (202) 767-2789
LOCATION:
NRL, Washington, DC

EMI Test Facility

EMI Test Facility

FUNCTION: The chamber supports electromagnetic interference/radio frequency interference (EMI/RFI) testing of flight hardware. It is also used to support custom RF testing up to 40 GHz.

INSTRUMENTATION: The chamber is equipped with a complete suite of instrumentation to do the full range of MIL-STD-461 EMI qualification testing. Computers with custom-developed software are used for instrumentation control, data handling, and data storage. Additional test equipment is available to do a variety of specialized testing during component design, through system integration and self compatibility.

DESCRIPTION: The facility consists of a 23 x 23-ft semi-anechoic main chamber with a 23 x 20-ft antechamber. It is a completely welded steel structure that provides a minimum of 120 dB of shielding effectiveness at 18 GHz and 100 dB up to 50 GHz. The main chamber uses a hybrid anechoic material consisting of wideband pyramidal absorbers and ferrite tiles for performance from 20 MHz to 50 GHz. A 10-ft high x 11-ft wide sliding bladder type door allows easy access of large test items to the main chamber. The steel floor rests directly on the concrete slab so floor loading is not an issue. Filtered and transformer isolated ac electrical power is available in both chambers: 100 A 120/208 V 3-phase services, and 60 A 120/240 V 1-phase services for each chamber.

CONTACT:
Code 8241 • (202) 404-4390
LOCATION:
NRL, Washington, DC

GENERAL INFORMATION

Maps

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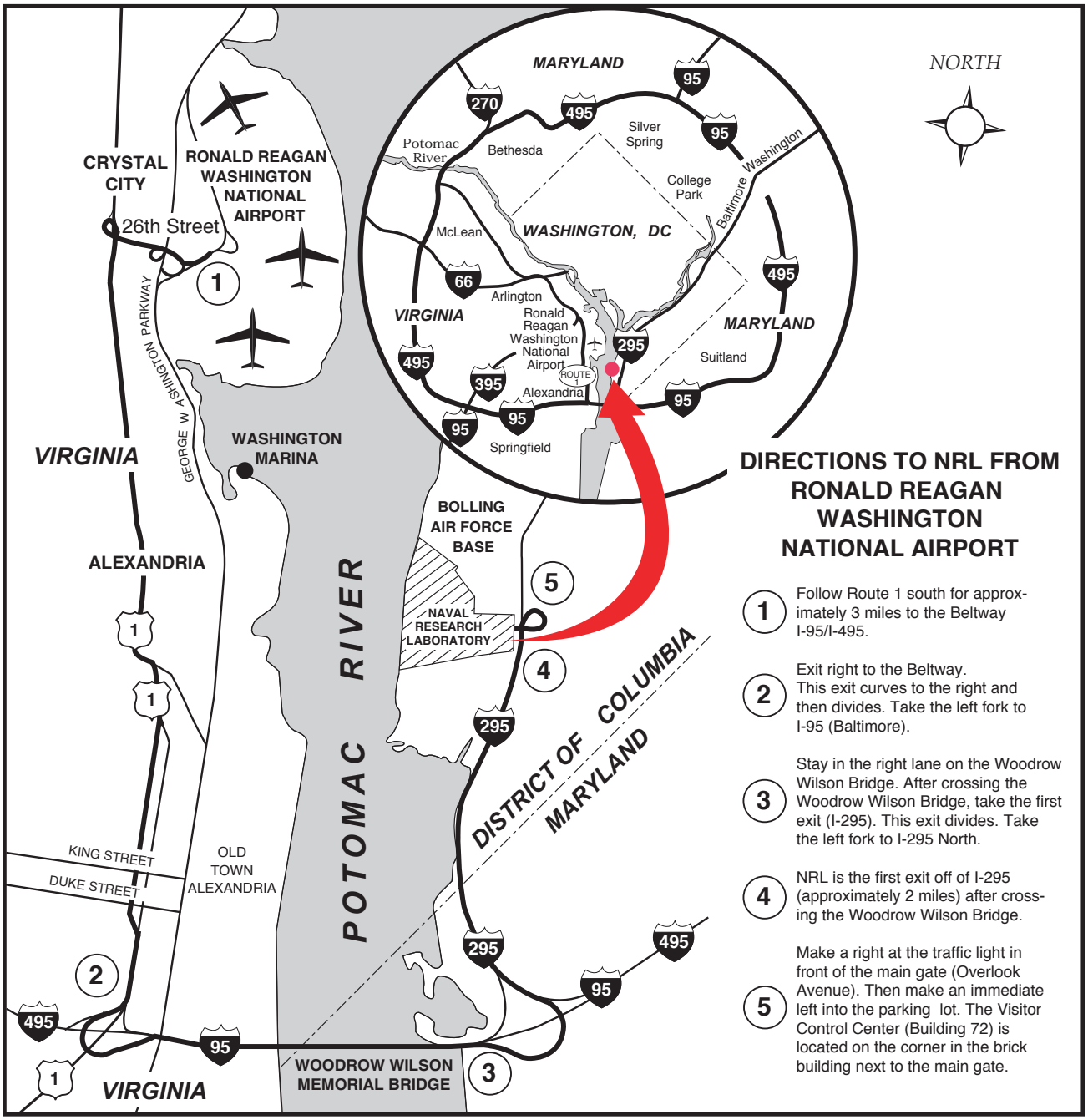
- Location of Field Sites in the NRL Washington Area
- Chesapeake Bay Section (Chesapeake Beach, MD)
- John C. Stennis Space Center (Stennis Space Center, MS)
- Naval Research Laboratory Monterey (Monterey, CA)

Naval Research Laboratory (Washington, DC)

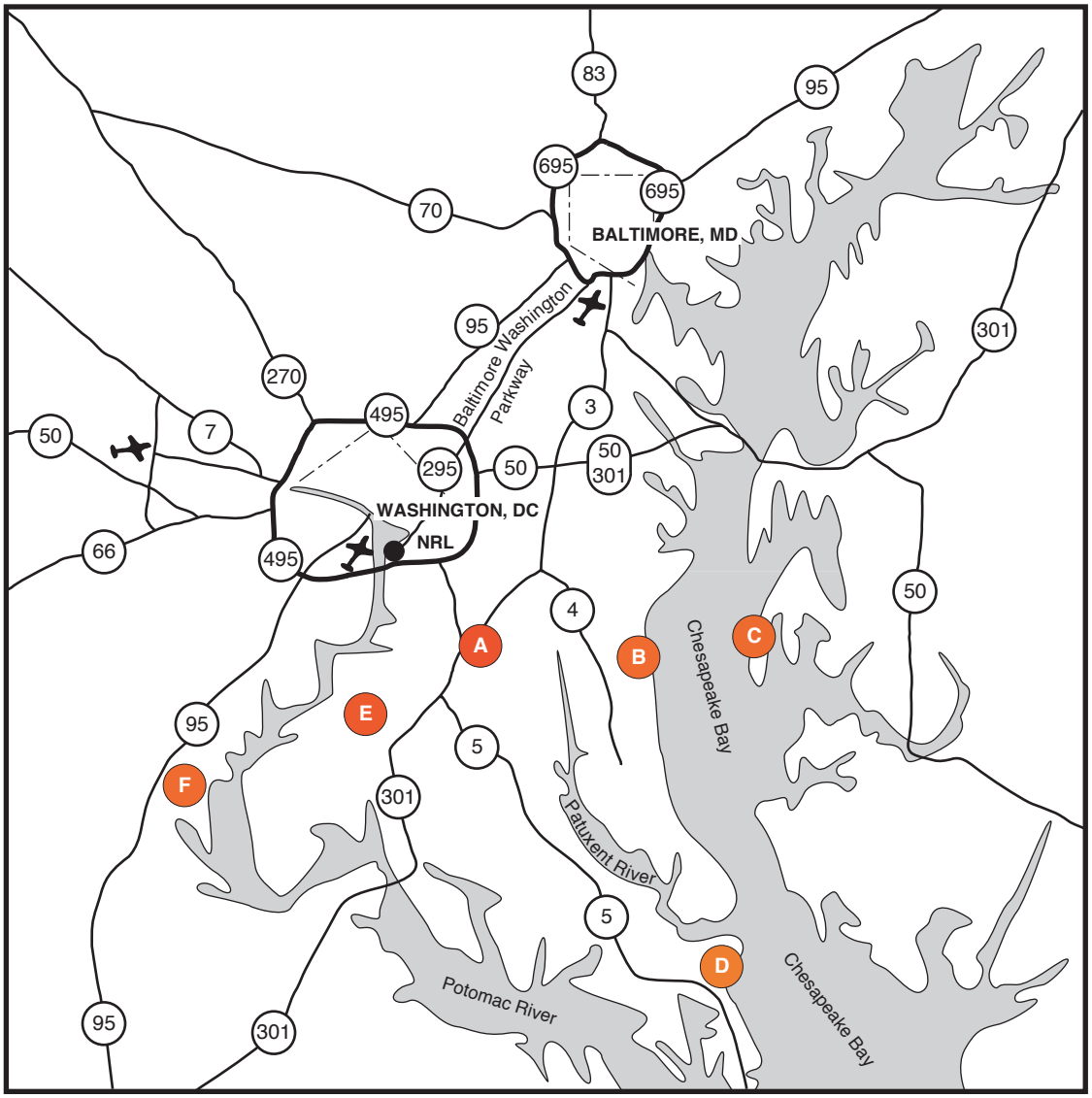


DIRECTIONS TO NRL FROM RONALD REAGAN WASHINGTON NATIONAL AIRPORT

1. Follow Route 1 south for approximately 3 miles to the Beltway I-95/I-495.
2. Exit right to the Beltway. This exit curves to the right and then divides. Take the left fork to I-95 (Baltimore).
3. Stay in the right lane on the Woodrow Wilson Bridge. After crossing the Woodrow Wilson Bridge, take the first exit (I-295). This exit divides. Take the left fork to I-295 North.
4. NRL is the first exit off of I-295 (approximately 2 miles) after crossing the Woodrow Wilson Bridge.
5. Make a right at the traffic light in front of the main gate (Overlook Avenue). Then make an immediate left into the parking lot. The Visitor Control Center (Building 72) is located on the corner in the brick building next to the main gate.

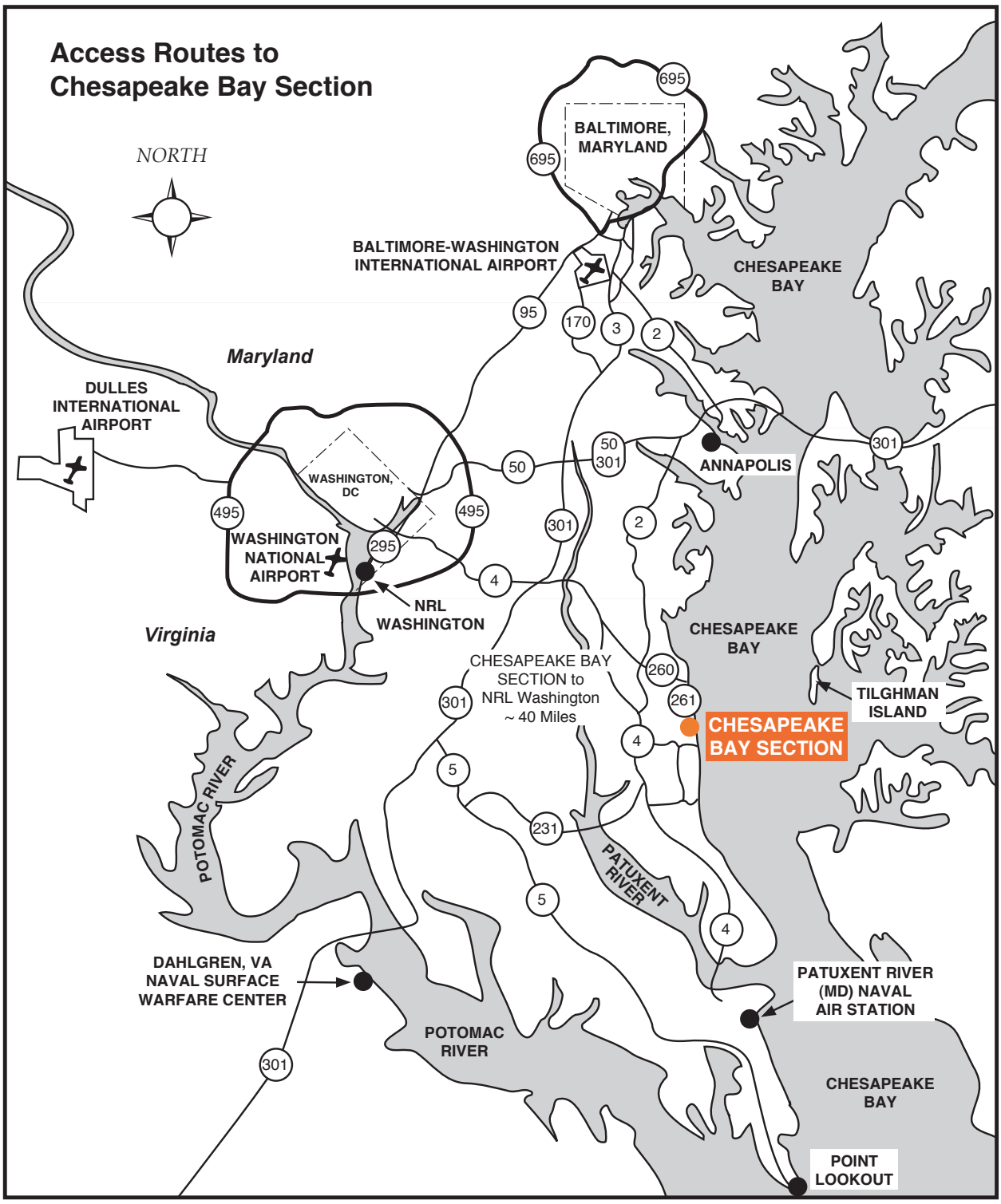
Naval Research Laboratory
4555 Overlook Avenue, SW
Washington, DC 20375-5320
(202) 767-3200

Location of Field Sites in the NRL Washington Area



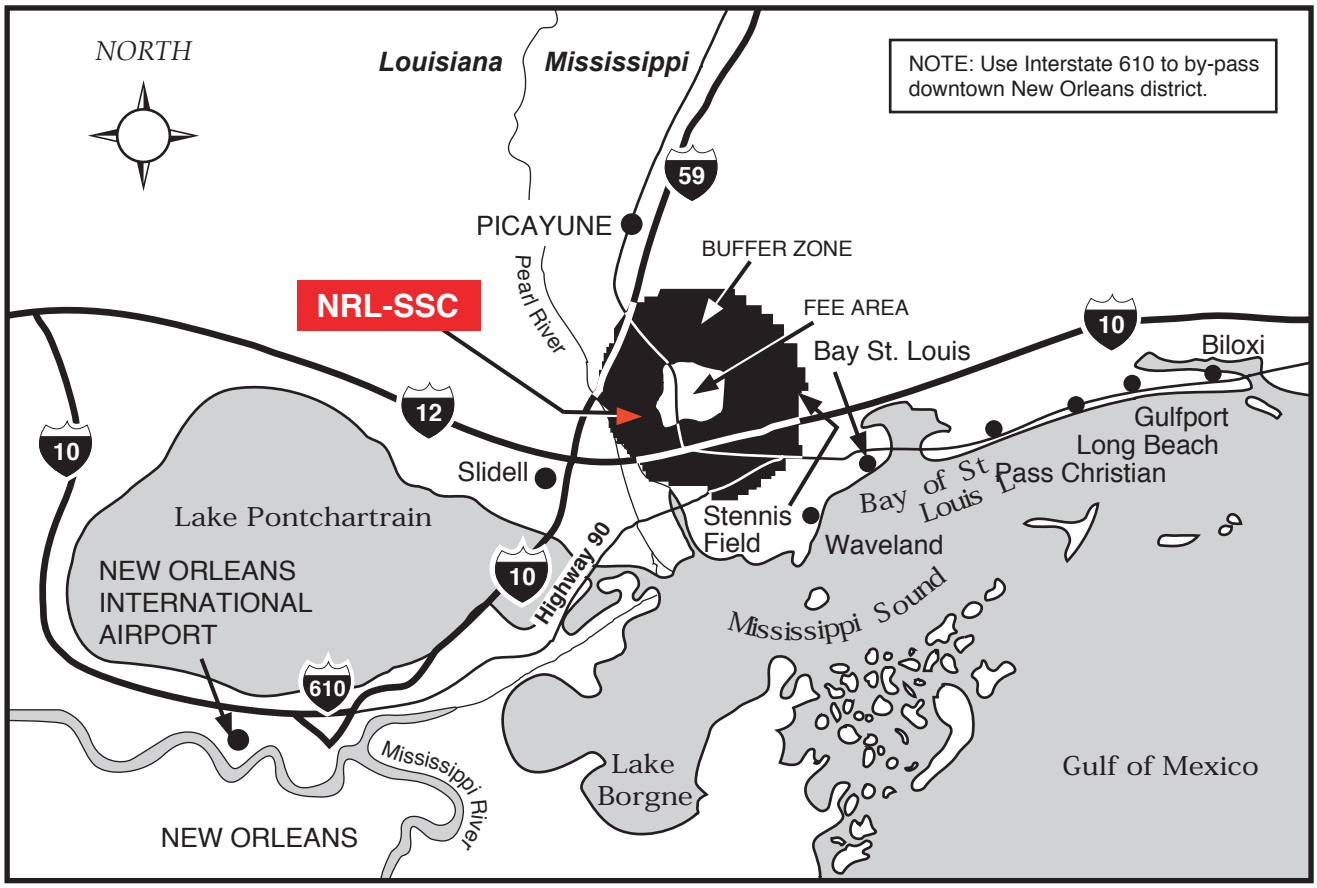
Location	Approximate Mileage from NRL Washington	Cognizant Code
A — Brandywine, MD	28	5500
B — Chesapeake Bay Section, Chesapeake Beach, MD	40	3522
C — Tilghman Island, MD	110	3522
D — Patuxent River (MD) Naval Air Station	64	1600
E — Pomonkey, MD	20	8106
F — Midway Research Center, Quantico, VA	38	8140

Chesapeake Bay Section
(Chesapeake Beach, Maryland)



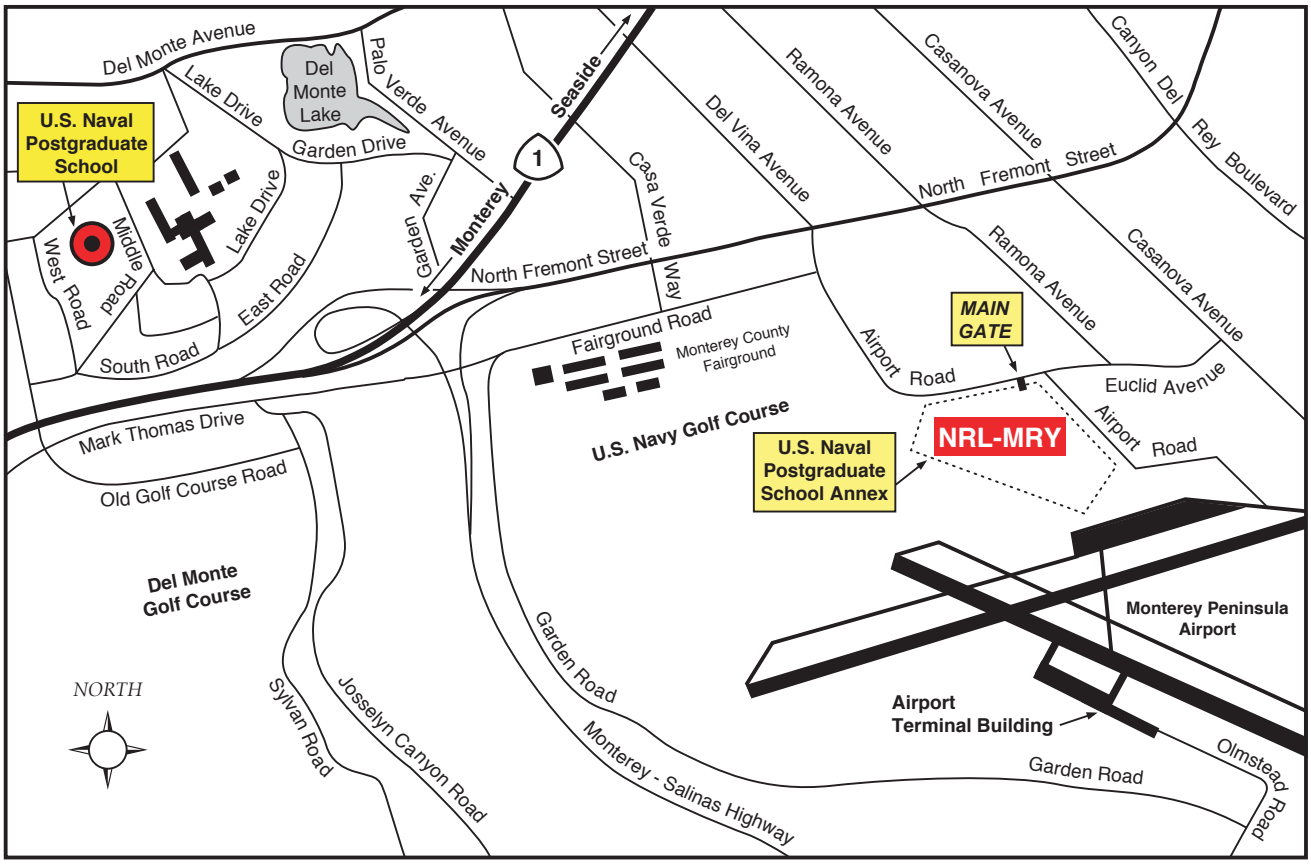
Naval Research Laboratory
Chesapeake Bay Section
5813 Bayside Road
Chesapeake Beach, MD 20732
(301) 257-4002

John C. Stennis Space Center
(Stennis Space Center, Mississippi)



Naval Research Laboratory
John C. Stennis Space Center
Stennis Space Center, MS 39529-5004
(228) 688-3390

Naval Research Laboratory Monterey (Monterey, California)



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7 Grace Hopper Avenue
Monterey, CA 93943-5502
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Commanding Officer